Transformer differential protection

Sepam 2000 D22 - D32
Merlin Gerin

Installation and user's manual

Merlin Gerin

Schneider Electric

Get more with the world's Power & Control specialist

Contents

Installation	**1/1**
Use - Commissionning	**2/1**
General characteristics	**3/1**
Testing	**4/1**

Contents

Use conditions **1/2**
Installation of Sepam 2000 1/2
Handling, transport and storage 1/2
Environment of the installed Sepam 2000 1/2

Identification of Sepam 2000 **1/3**

Equipment identification **1/4**
Accessories supplied with Sepam 1/4
Optional accessories 1/5
Communication accessories 1/5

Assembly and wiring **1/6**
Dimensions and drilling 1/6
Assembly 1/6
Sepam 2000 components 1/7
Connections 1/7
Terminal identification principle 1/7

Use and connection of current inputs to CTs **1/8**
1 A or 5 A CT connection diagram 1/8
Selection of operating modes (microswitches) 1/8
CCA 660 or CCA 650 connector 1/9

Use and connection of CSH 30 interposing ring CT **1/10**
CSH interposing ring CT 1/10
Assembly 1/10
Wiring 1/10
Connection to the 1 A secondary circuit 1/11
Connection to the 5 A secondary circuit 1/11
Selection of operating modes (microswitches) 1/11

Connection of power supply and logic inputs and outputs **1/12**
Connection of power supply and earth 1/12
Connection of logic inputs and outputs 1/12

Connection of the Jbus/Modbus communication coupler **1/13**

Replacement of Sepam 2000 D01 and Sepam 2000 D22 **1/14**
Assembly 1/14
Sepam 2000 D22 settings 1/14
Communication 1/14

Use conditions

Installation of Sepam 2000

Each Sepam 2000 comes in a single package which contains:
- Sepam 2000
- mounting accessories
- connection accessories (connectors).

The other optional accessories come in a separate package.
We recommend that you follow the instructions given in this document for quick, correct installation of your Sepam 2000:
- equipment identification
- assembly
- connection of current and voltage inputs, probes
- microswitch setting
- connection of power supply and earth
- checking prior to commissioning.

Handling, transport and storage

Sepam 2000 in its original packaging

Transport:
Sepam 2000 may be shipped to any destination without taking any additional precautions by all usual means of transport.

Handling:
Sepam 2000 may be handled without any particular care and can even withstand being dropped by a person handling it (person standing on floor).

Storage:
Sepam 2000 may be stored in closed premises for several years. Periodic, yearly checking of the environment and the packaging condition is recommended.

Sepam 2000 installed in a cubicle

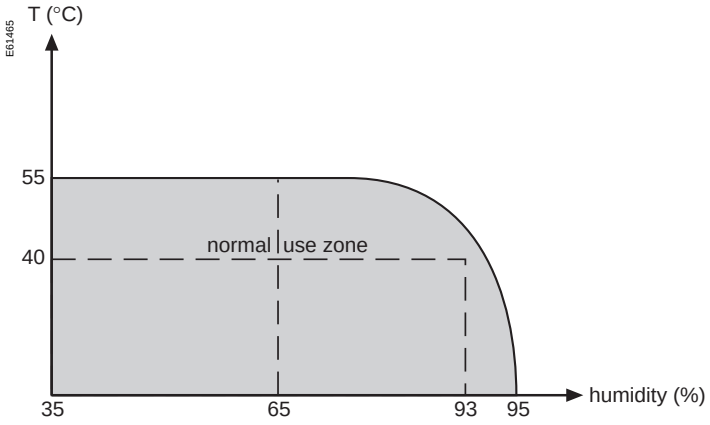
Transport:
Sepam 2000 may be transported by all usual means of transport in the customary conditions used for cubicles. Storage conditions should be taken into consideration for a long period of transport.

Handling:
Should the Sepam 2000 fall out of a cubicle, check its condition by visual inspection and energizing. If there is any doubt, return the Sepam 2000 for checking in the factory.

Storage:
Keep the cubicle protection packing for as long as possible. Sepam 2000, like all electronic units, should not be stored in a damp environment for more than a month. Sepam 2000 should be energized as quickly as possible. If this is not possible, the cubicle reheating system should be activated.

Environment of the installed Sepam 2000

Operation in a damp environment
The temperature/relative humidity factors must compatible with the unit's environmental withstand characteristics.
If the use conditions are outside the normal zone, commissioning arrangements should be made, such as air conditioning of the premises.



Operation in a polluted atmosphere
Sepam 2000 is designed to be used in a clean industrial environment as defined by IEC 60654-4 class 1. A contaminated industrial atmosphere components (such as the presence of chlorine, hydrofluoric acid, sulfur, solvents…) may cause corrosion of the electronic components, in which case environmental control arrangements should be made (such as closed, pressurized premises with filtered air,…) for commissioning.

Identification of Sepam 2000

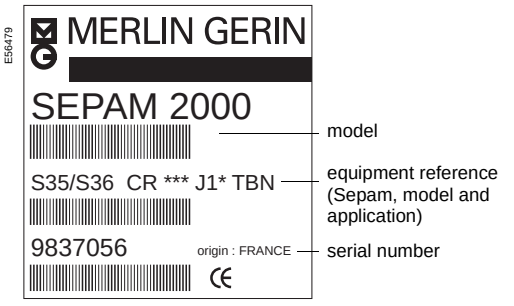
Each Sepam is identified by a 14-character reference which describes its hardware and functional composition in accordance with the chart below.

Series	Model	Type	Variant	Communication	Number of ESTOR boards	Operating language	Current sensor	Auxiliary supply	Operating temperature
S36	CR	D=differential	22 = 2 ends	X = without	0 = 0	F = French	T = CT	A = 24Vdc	N = -5/55 °C
	CC		32 = 3 ends	J = Jbus/Modbus	1 = 1	A = English		B = 48/125Vdc	
					2 = 2	I = Italian		C = 220Vdc	
					3 = 3	E = Spanish			

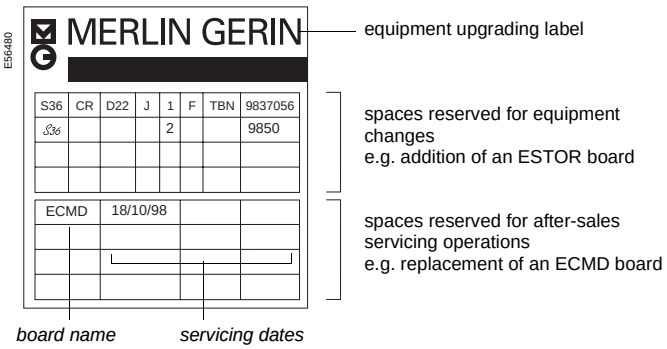
There are five labels for identifying Sepam:
- two labels on the right side panel which give the product's hardware features (1)
- a label on the front of the cartridge which gives the functional features (2)
- a label on the left side of the cartridge which includes its references (3)
- a label on the right side of the cartridge which may be used to note the references of a non-standard control logic scheme (4).

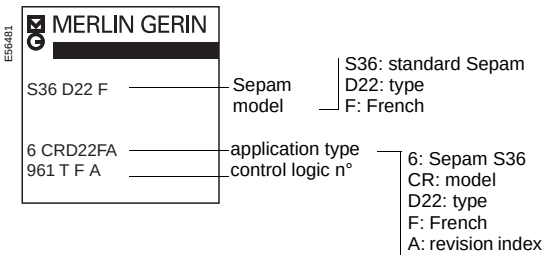
Example of Sepam references:

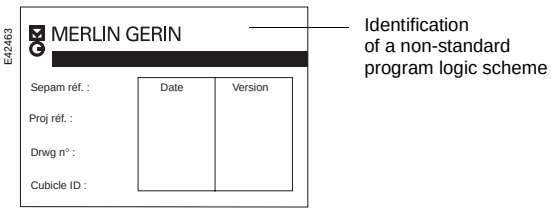
S36	Sepam 2036
CR	Type
D	Differential
22	2 windings
X	no communication
1	1 ESTOR boards
F	French
T	CT
B	48 - 125 V
N	-5/+55 °C



***(1)** Example of label on right side panel*







***(4)** Label on the right side of the cartridge.*

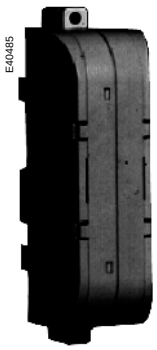
***(2)** Example of label on the front of the cartridge.*

***(3)** Example of a label on the left side of the cartridge.*

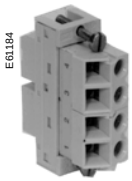
Equipment identification

Accessories supplied with Sepam

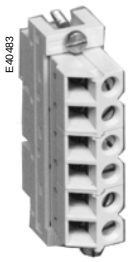
Each Sepam 2000 comes with the following accessories:



CCA 660 connector for connection of 1 A or 5 A CT:
- for 4 mm eye lugs
- for max. 6 mm^2 wire (AWG 10).



CCA 604 connector
4 points connector.
Connection of power supply:
- screw terminals
- 0.6 to 2.5 mm^2 wire (AWG 20 to AWG 14).



CCA 606 connector
6 points connector.
Connection of a core balance TC:
- screw terminals
- 0.6 to 2.5 mm^2 wire (AWG 20 to AWG 14).

CCA 621 connector
21 points connector.
Connection of logic inputs/outputs:
- screw terminals
- 0.6 to 2.5 mm^2 wire (AWG 20 to AWG 14).

2 Sepam 2000 mounting lugs

Equipment identification

E61745

Optional accessories

TSM 2001 pocket terminal
Used to mount Sepam 2000 settings.
It does not have a battery since it is supplied with power by Sepam 2000.

MT10583

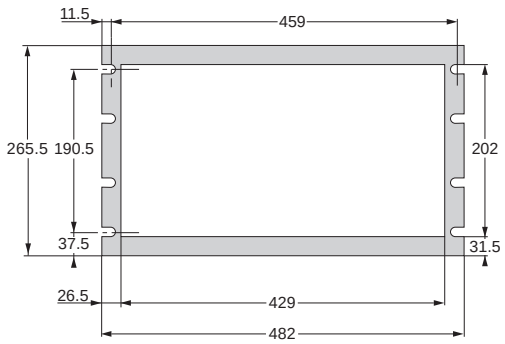
ACE 900 adapter to be connected to the pocket terminal inlet.

SFT 2801 / SFT 2821 kit
■ The SFT 2801 software tool installed on a PC microcomputer may be used instead of the TSM 2001 pocket terminal.
■ The SFT 2821 software tool installed on a PC may be used to:
□ prepare a protection setting file and transfer it to Sepam 2000 via the pocket terminal connection
□ transfer to a PC, via the pocket terminal connection, all the Sepam 2000 protection settings and store them in a file.

These software tools are delivered together. They comprise:
■ three 3"1/2 diskettes
■ an instruction manual
■ a connection kit (ACE 900 interface + cord).

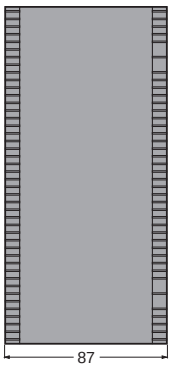
In the rest of the document, the term "pocket terminal" refers to both the TSM 2001 pocket terminal and the SFT 2801 kit.

E61463



AMT 819 plate
Used to mount Sepam 2000 on a 19" rack.

E61367



E61098

AMT 820 shield
Used to block off the space between Sepam and the edge of the AMT 819 plate.

Communication accessories

CCA 602 cable
3 m long cable with connectors supplied Sepam 2000 equiped with the communication option.

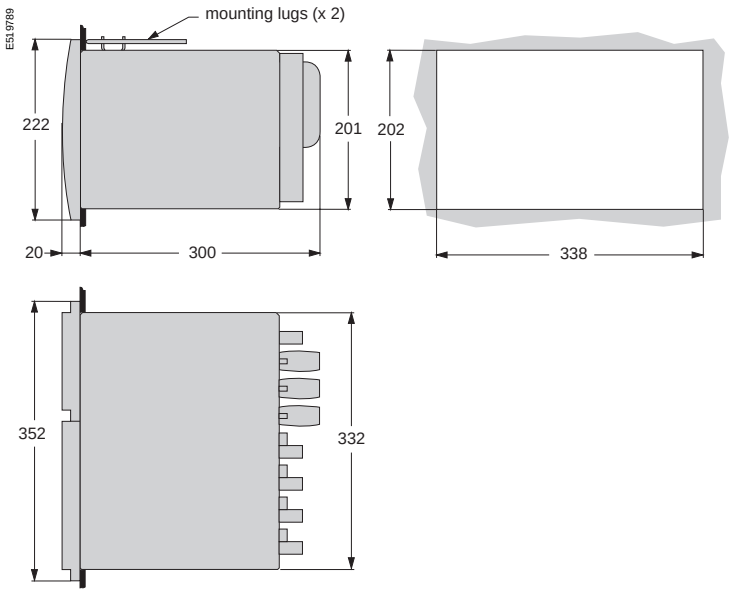
Refer to the "RS485 communication network connection guide".

Assembly and wiring

Dimensions and drilling

Sepam 2000 is flush mounted in a rectangular cut-out.
Maximum thickness of mounting: 3 mm

Drilling diagram

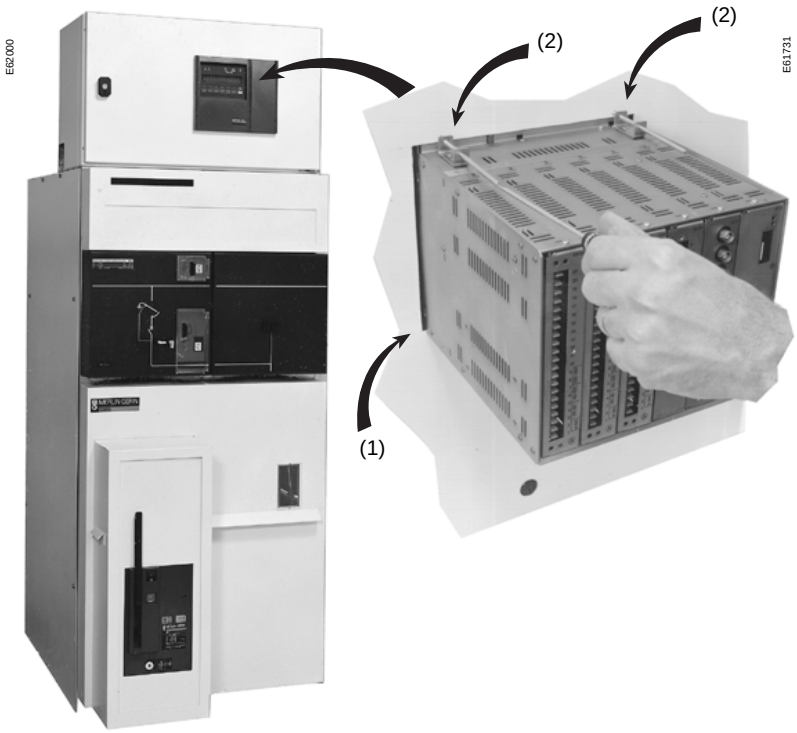


Assembly

■ Insert Sepam 2000 through the front of the cut-out. Slide it into the cut-out until the front of Sepam 2000 is in contact with the mounting plate. The 2 notches (1) at the base of the Sepam 2000 case allow it to hold by its own weight.

■ Position the 2 lugs (2) in the holes on the top of Sepam 2000.
Tighten the threaded studs of the lug.

■ Make sure not to block the ventilation openings on the top and bottom of Sepam 2000.
Leave a space of at least 5 cm above and below Sepam 2000.



Assembly and wiring

Sepam 2000 components

Slot numbers of Sepam 2000 boards

	Slot							
	8	7	6	5	4	3	2	1
S36 CR			ESTOR	ESB	-	ECMD	ECMD	CE40
S36 CC	ESTOR	ESTOR	ESTOR	ESB	ECMD	ECMD	ECMD	CE40

Connections

The Sepam 2000 connections are made on the removable connectors located on the rear of the device.
All the connectors are screw-lockable.

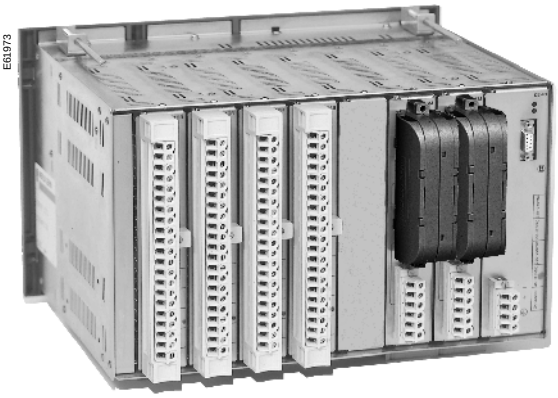
Wiring of screw connectors:

- Recommended wire fittings:
  - Telemecanique DZ5CE0155 for 1.5 mm^2
  - DZ5CE0253 for 2.5 mm^2.

Stripped length with fitting: 17 mm.

- Without fitting:
  - stripped length: 10 to 12 mm
  - maximum 2 wires per terminal.

The 21-pin connectors must be connected correctly by hand before being locked by the 2 screws (top/bottom).



Terminal identification principle

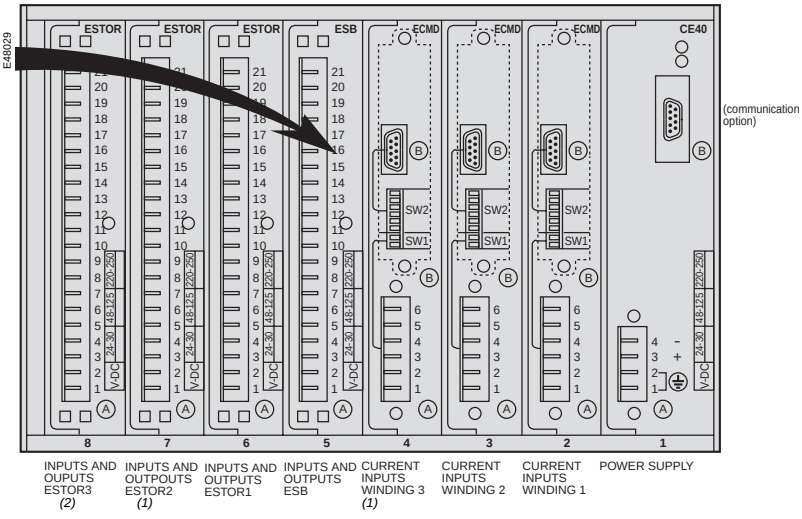
All the Sepam 2000 connection terminals are located on the rear of the device.
The Sepam 2000 boards are fitted into the rear slots numbered 1 to 8.
The connections are identified by adding different markings:

- slot (1 to 8)
- connector A or B
- terminal (1 to 21).

Example: 5 A16
slot n°5, connector A, terminal 16.

Each connector is used for a specific functional unit identified in the top right-hand corner according to the function:

- CE40: auxiliary supply and communication option
- ECMD: current sensor (CT) interface
- ESB: control interface
- ESTOR: control interface.

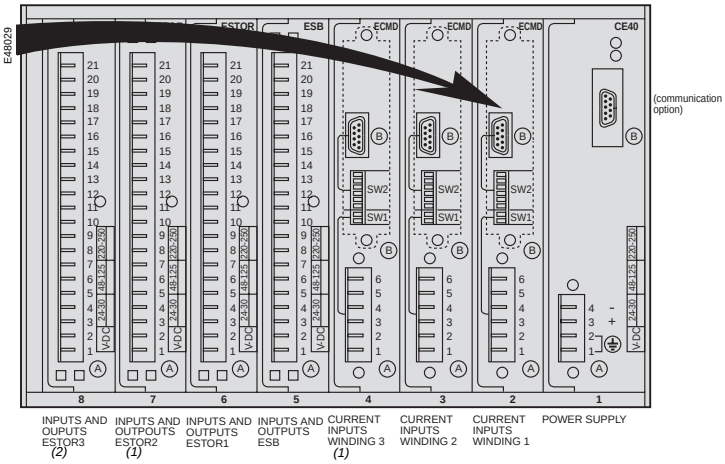


***(1)** Sepam 2000 D32 only*
***(2)** In option for D32 application only*

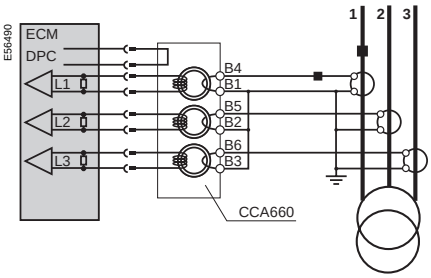
Use and connection of current inputs to CTs

1 A or 5 A CT connection diagram

The current transformer (1 A or 5 A) secondary circuits are connected to the CCA 660 connector on the ECMD module.
The connector contains 3 core balance CT primary-throught adapters to ensure impedance matching and isolation between the 1 A or 5 A circuits and Sepam 2000.
The connector may be disconnected with the power on since disconnection does not open the CT's secondary circuit.



(1) *Sepam 2000 D32 only*
(2) *In option for D32 application only*



Sepam 2000 current inputs

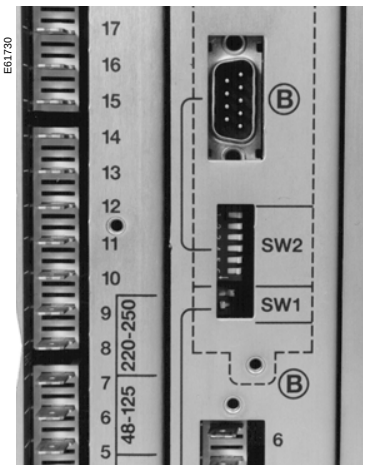
Selection of operating modes (microswitches)

Sepam 2000 has several possible operating modes. The operating mode is selected via microswitches on the rear of the device. They must be set before Sepam 2000 is put into service.

The microswitches must be switched while the Sepam 2000 is de-energized.

They are hidden by the CCA connector once it has been installed.

Please note: Sepam 2036 models CR and CC have several inputs for connecting CTs. Remember to set the microswitches for all the inputs.

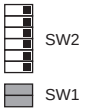


Microswitch setting

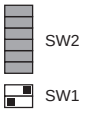
5 A CT

For use on the 5 A secondary circuit.

1 A CT



For use on the 1 A secondary circuit.



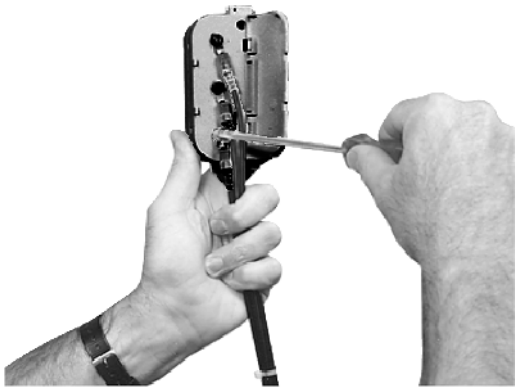
For measuring neutral point current.

Use and connection of current inputs to CTs

CCA 660 or CCA 650 connector

■ Open the 2 side shields for access to the connection terminals. The shields may be removed, if necessary, to facilitate wiring. If removed, replace them after wiring.
■ Remove the bridging strap if necessary.
The strap links teminals 1, 2 and 3.
■ Connect the wires using 4 mm eye lugs.
The connector accommodates wires with cross sections of 1.5 to 6 mm^2 (AWG 16 to AWG 10).
■ Close the side shields.

E40488

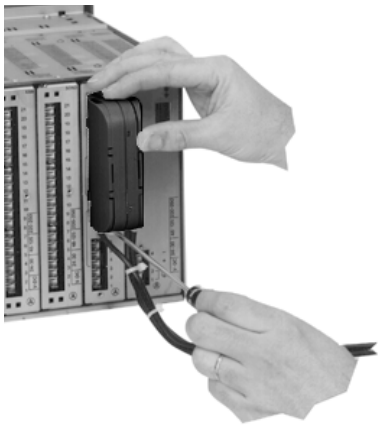


■ Plug the connector into the 9-point inlet on the rear of the device. Item B on the ECMD module.

E61187

■ Tighten the CT connector fastening screws on the rear of Sepam 2000.

E61186



Use and connection of CSH 30 interposing ring CT

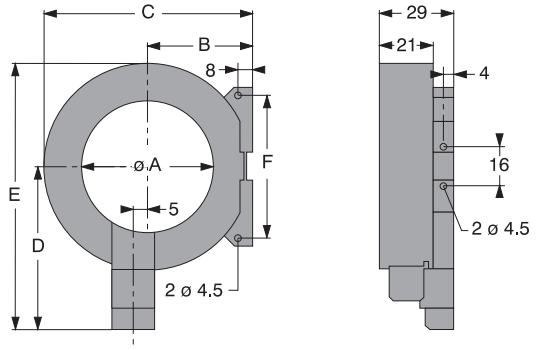
CSH interposing ring CT

The CSH 30 interposing ring CT should be used when residual current is measured by a current transformer with a secondary circuit (1 A or 5 A).
It acts as an adapter between the CT and the Sepam 2000 residual current input.
It should be connected to the CT input of the Sepam 2000 and installed near the corresponding Sepam input (max. 2 m).

Characteristics

- inner diameter: 30 mm
- accuracy: ± 5%
- transformer ratio: 1/470
- maximum permissible current: 20 kA-1 second
- operating temperature: - 25°C to + 70°C
- storage temperature: - 40°C to + 85°C
- maximum metering current: 10 Ino.

E61461

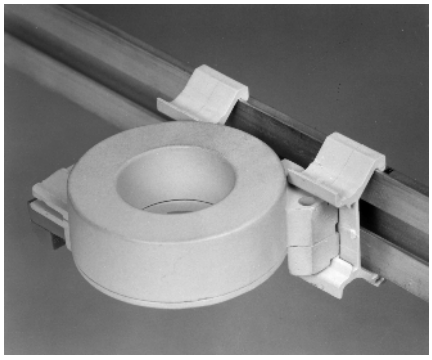


Dimensions (mm)						**Weight** (kg)
A	B	C	D	E	F	
30	31	60	53	82	50	0.12

Assembly

The CSH 30 interposing ring CT is mounted on a symmetrical DIN rail. It may also be mounted on a plate through the mounting holes provided on its base.

E44717



Horizontal mounting on DIN rail.

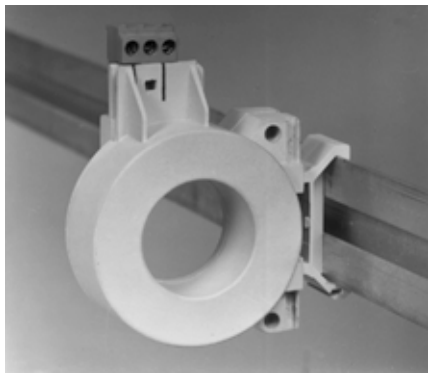
Wiring

The cable must be inserted into the CSH 30 interposing ring CT in the right direction in order for the directional earth fault protection to operate correctly: the cable coming from S2 of the CT must be inserted through the P2 side of the CSH 30 core balance CT.
The secondary winding of the CSH 30 is connected to the CCA 606 6-pin connector.
Cable to be used:

- sheathed, shielded cable
- min. cable cross-section 0.93 mm2 (AWG 18) (max. 2.5 mm^2)
- resistance per unit length < 100 mΩ/m
- min. dielectric strength: 1000 V.

Connect the CSH 30 interposing ring CT connection cable shield in the shortest manner possible (2 m maximum) to the Sepam 2000 6-pin connector. Flatten the cable against the metal frames of the cubicle. The connection cable shielding is grounded in Sepam 2000. Do not ground the cable by any other means.

E40468

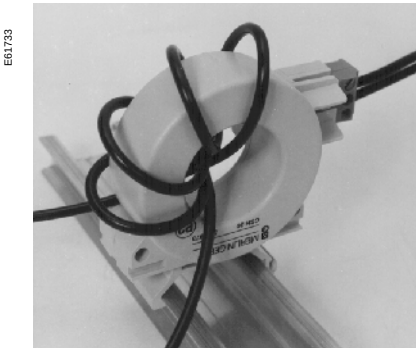


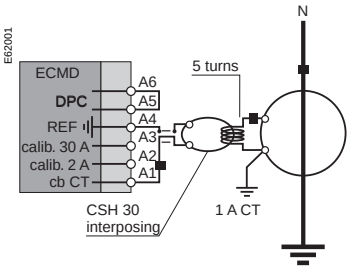
Vertical mounting on DIN rail.

Use and connection of CSH 30 interposing ring CT

Connection to the 1 A secondary circuit

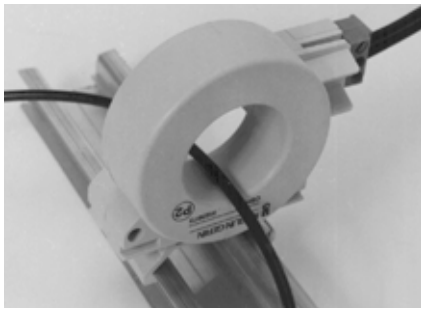
■ Plug into the CCA 606 connector.
■ Wind the transformer secondary wire around the CSH 30 interposing ring CT 5 times.

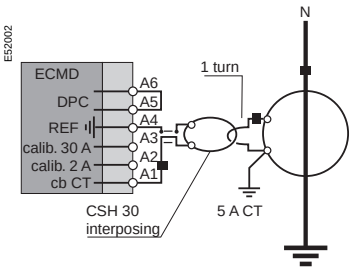




Connection to the 5 A secondary circuit

■ Plug into the CCA 606 connector.
■ Wind the transformer secondary wire once around the CSH 30 core balance CT.

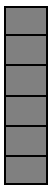




Selection of operating modes (microswitches)

The SW1 micro-switches are found on the rear of the device. They must be set before Sepam 2000 is put into service.
They should be switched while the Sepam 2000 is de-energized.
The microswitches are hidden by the CCA 660 connector once it has been installed.

Please note:
Sepam 2036 models CR or CC have some inputs for connecting CTs. Remember to set the micro-switches of all inputs.



SW2

SW1 For neutral point current measurement.

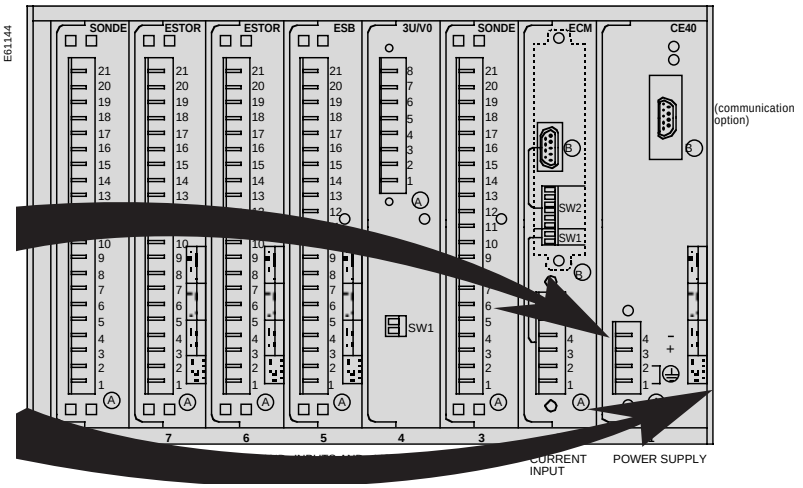
Connection of power supply and logic inputs and outputs

Connection of power supply and earth

The Sepam 2000 power supply is connected to the CCA 604 4-point terminal block on the CE40 module situated on the rear of the device.
The power supply input is protected against accidental polarity inversion.

Safety:
The Sepam 2000 chassis must be earthed via the grounding screw situated on the right side panel (rear view).

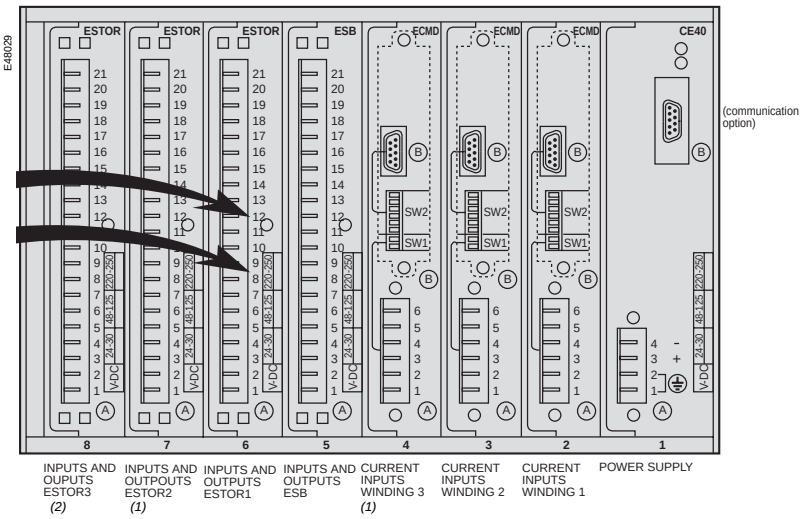
Use a braid or cable fitted with a 4 mm eye lug. The eye lug fastening screw is already mounted on Sepam 2000 when it is delivered.
(Should this screw be lost, never replace it by a screw longer than 8 mm).



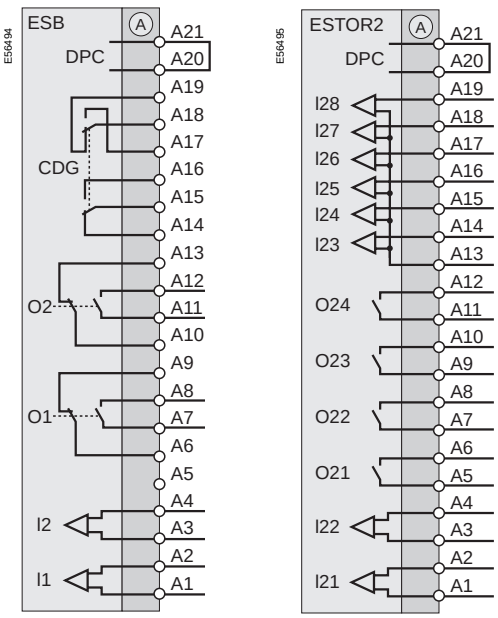
Connection of logic inputs and outputs

The logical data are connected to the CCA 621 connector on the ESB and ESTOR modules.
Check that the voltage applied to the inputs is compatible with the permissible voltage indicated by a dot on the subassembly.

Cabling should be done in accordance with the diagram given in the technical manual for your Sepam (Sepam 2000 D22 or Sepam 2000 D32).



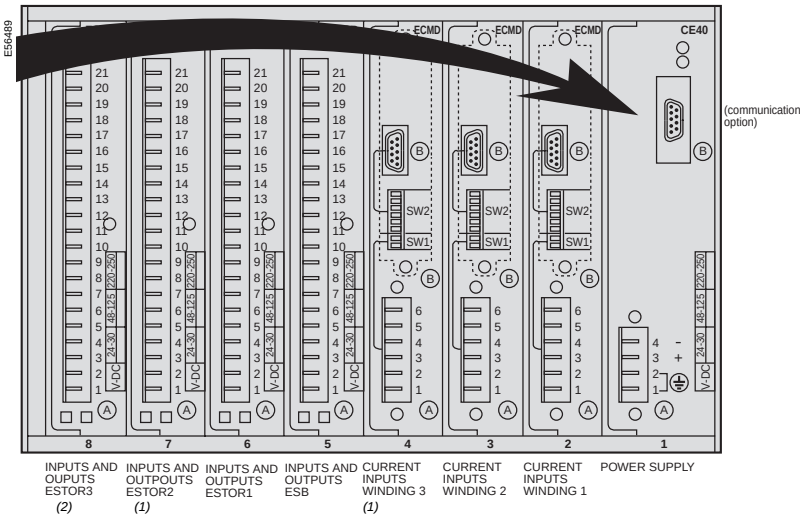
***(1)** Sepam 2000 D32 only*
***(2)** In option for D32 application only*



Example: ESTOR and ESB.

Connection of the Jbus/Modbus communication coupler

Sepam 2000 can be equipped, as an option, with a communication coupler situated on the CE40 coupler.
Please refer to the "RS 485 network connection guide" and "Sepam 2000, "Jbus/Modbus communication" documents for commissioning instructions and the choice of accessories.
A CCA 602 cable (optional), 3 meters long, fitted with a 9-pin plug at either end, may be used to connect the coupler directly to the CCA 609 network connection box (optional).
This box allows quick connection to the communication network and does all the earthing necessary for dependable operation.



(1) *Sepam 2000 D32 only*
(2) *In option for D32 application only*

Replacement of Sepam 2000 D01 and Sepam 2000 D22

Sepam 2000 D01 and D02 units may be replaced by a Sepam D22. The following precautions must be taken during the replacement operation.

Assembly

The sizes and drilling dimensions are the same regardless of the type of Sepam 2000 used.

Connection of phase inputs
The CCA 651 phase current input connectors may be kept or replaced by CCA 660 connectors.

Connection of neutral point current inputs
It is only necessary to connect the neutral point current inputs for the use of the F65 restricted earth fault protection.

Other connections
They are all the same unless the control logic has been customized.

Sepam 2000 D22 settings

Protection	
Transformer differential (F601)	Id/It = unchanged
Restricted earth fault (F651)	setting unchanged
Parameter	settings unchanged
Control logic	
Time delay	settings unchanged
Parameter	settings unchanged
Status	
Rated frequency	settings unchanged
CT ratio CT' ratio	the setting is limited to the In and In' setting (CT rating)
Io' sensor	any setting for a D01
	setting unchanged for a D02
Transformer	S: transformer power
	Un: rated voltage of winding 1 connected to the ECMD2 board
	Un': rated voltage of winding 2 connected to the ECMD3 board
	Index': vector group of winding 2 compared to winding 1
Disturbance recording (1)	setting to be defined according to operation
Communication	settings unchanged
Time-tagging	settings unchanged

Communication

Given the change of application, access to the settings by remote reading is different for the following functions:

Functions	Differences
Différential transformer	the function number is 60 instead of 59
	the number of settings is reduced from 3 to 1
CT ratio CT' ratio	the number of settings is reduced from 3 to 1
Transformer	new function with 4 settings
Disturbance recording (1)	access to the setting prétrig

***(1)** Available as of version 9940 SFT 2800.*
For earlier versions, pretrig is equal to 24 periods.

Contents

Front face Sepam 2000 **2/2**

TSM2001 / SFT2801 pocket terminal **2/3**
Setting tools 2/3
Example of use 2/4

Password and Sepam identification **2/5**
Use of the password 2/5
Sepam Identification using the pocket terminal 2/5

Current operation **2/6**
Operation via the pocket terminal 2/6
Event counter 2/7
Annunciation 2/7
List of messages 2/7

Checking prior to commissioning **2/8**
Supply voltage 2/8
Earthing 2/8
Cartridge 2/8
Setting of microswitches on rear 2/8
Connector 2/8

Commissioning using the TSM 2001 pocket terminal **2/9**
Switch on the Sepam 2/9
Checking mode 2/9
Parameter setting mode (1) 2/9
Parameterization and setting errors 2/9

Parameter and protection settings **2/10**
Status menu parameter chart 2/10
Protection function setting ranges 2/11
Control logic and annunciation 2/11
Control logic resource chart 2/11

Connection of logic inputs **2/12**

Connection of logic outputs **2/13**

Program logic parameters **2/14**
Parameter setting 2/14
Time delays 2/14

Utilization of program logic **2/15**
D22 operation 2/15
Exploitation Sepam 2000 D32 2/15

Disturbance recording **2/16**
Activation of disturbance recording 2/16
Data recorded 2/16

Setting record sheet **2/17**

Maintenance **2/18**
Indicator lamps and display messages 2/18
Communication indicator lamps 2/19
Unwanted tripping, no tripping 2/19
Tests 2/19
Sepam replacement 2/19

Front face Sepam 2000

1. status indicators
2. display
3. keys for access to alarm processing
4. cartridge
5. pocket terminal pocket

■ **Status indicators** (1)
- green **on** indicator: lamp shows that Sepam 2000 is energized
- red **trip** indicator lamp: Sepam 2000 has tripped the circuit breaker after detecting a fault. A related alarm message indicates the cause of tripping
- red indicator: lamp shows internal Sepam faults. All the output relays are dropped out (fail-safe position). Refer to the chapter on maintenance
- green **test** indicator: Sepam 2000 is in this mode. Refer to the "Testing" chapter.

■ **Display** (2)
The display unit indicates operating and maintenance messages.

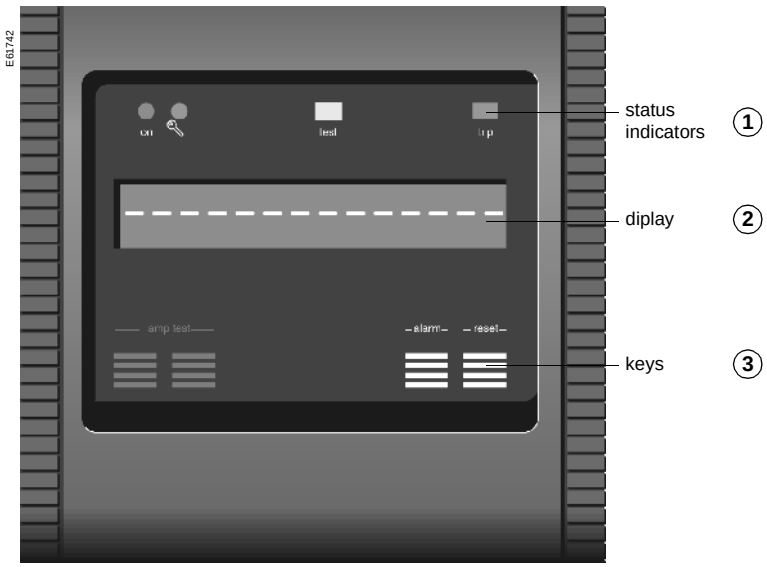
■ **Keys for access to alarm processing** (3)
- **alarm processing** key
- **alarm** key: each time tripping or another event occurs, an alarm message stored in a list of alarms is displayed.

The most recent message appears on the display.
This key provides access to step by step reading of the list of stored alarm messages. The previous message may be displayed by pressing this key.
Display of: ---------- indicates the end of the list of alarm messages.
- **reset** key: the protections trigger circuit breaker tripping and display of the related messages.

The red trip indicator lamp lights up. After the fault has been cleared, the user presses the **reset** key to acknowledge. The **trip** indicator is extinguished, the list of alarms is erased and the device can be closed. The reset key is disabled until the fault has been cleared.
- **lamp test** keys: indicator lamp and display unit operation may be tested by pressing the two keys at the same time.

■ **Cartridge** (4)
The cartridge contains the information required for Sepam 2000 operation, such as:
- settings,
- stored data,
- control and monitoring logic…

■ **Pocket terminal socket** (5)
This socket is used to connect the TSM 2001 pocket terminal or the ACE 900 adapter to the SFT 2801 / SFT 2821 kit (PC link).



TSM2001 / SFT2801 pocket terminal
Setting tools

E61745

The TSM 2001 pocket terminal and the SFT 2801 software for PC operate in the same way.
The TSM 2001 pocket terminal provides access to all the Sepam 2000 data such as:
- operating assistance messages
- protection settings.

The pocket terminal is supplied with power by Sepam 2000 and does not require any batteries; it can be connected with the power on.
The pocket terminal beeps when it is connected.
The main menu appears. If not check the brightness adjustment using the dial ☼
The user may access the various items of information from three menu levels.
A menu may comprise several pages.
To access a menu, simply position the blinking cursor on the desired line and press the **enter** key.
The first line of the menu contains the name of the current menu or function.
Indication of **P/** at the top of the menu shows that the user has entered the password.

E48125

```
P/Select:
  Protection
  Program logic
■ Add. reading
```

E48135

```
P/Select:
■ Status
  About Sepam
```

Nota : *the first line always contains the name of the current menu or function.*

Role of the keys:

- The pocket terminal beeps when the user presses a key that is disable.

- The **menu** key is used to display the previous menu.

- The ▲ and ▼ keys are used to move the cursor one line up or down in a menu.
To move to the next screen of a menu, the user simply positions the cursor on the last line and presses the ▼ key.
To move to the previous screen of a menu, the user simply positions the cursor on the second line and presses the ▲ key.

- The **code** key is used to enter and exit the parameter setting mode.

- The **numeric** and **.** keys are used to enter settings and the password.

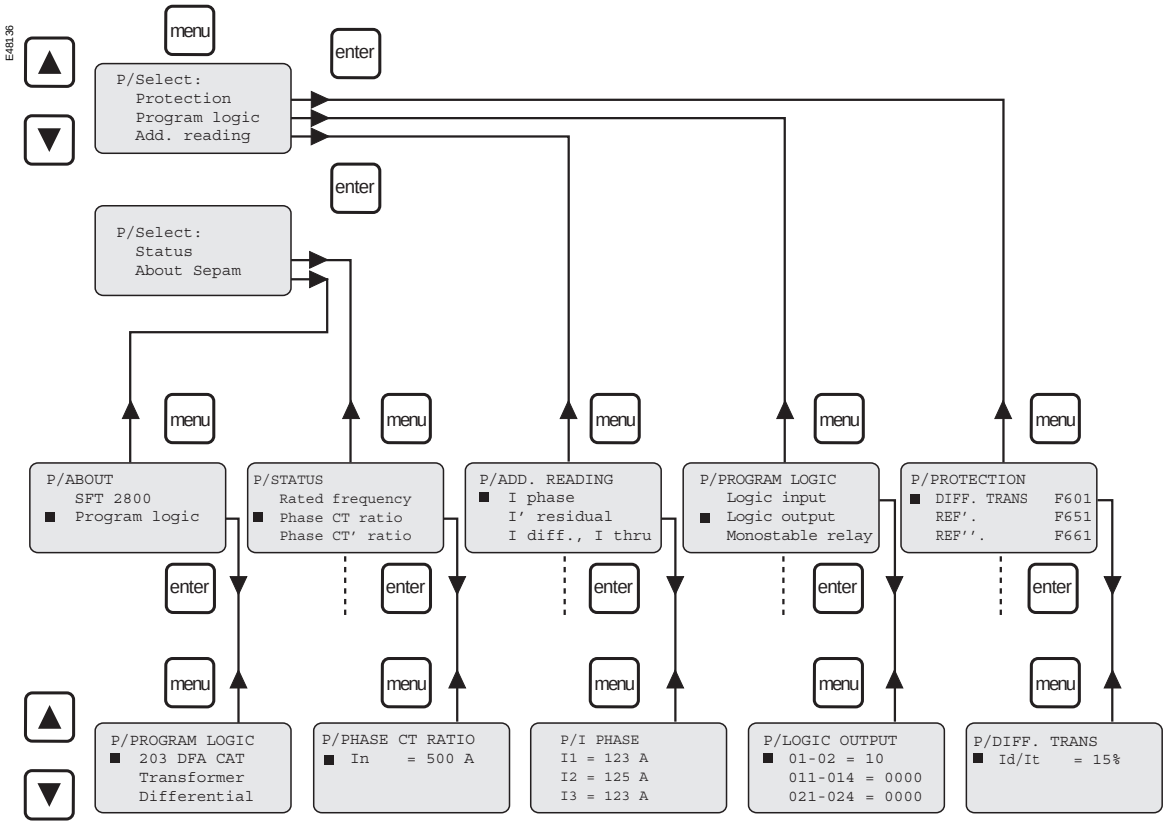
- The **units** key is used to change setting unit multiplying factors (e.g. A, kA, …).

- The **data+** and **data-** keys are used to select setting values from a predefined data table.

- The **clear** key is used:
  - ▫ to clear error messages
  - ▫ to call back a previous setting value during data input
  - ▫ to reset tripping currents and maximum demand readings to zero.

- The **enter** key is used to confirm a menu selection or to confirm all the settings for a function.

TSM2001 / SFT2801 pocket terminal
Example of use



Example of use of the SFT 2801 software with Sepam 2000.

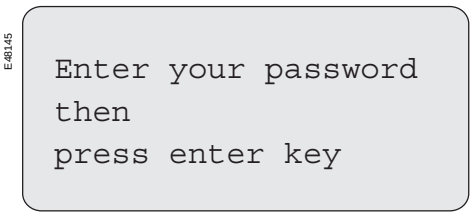
Password and Sepam identification

Use of the password

The user enters a password via the pocket terminal in order to be able to change parameters and settings.

Code key

When the user presses the **code** key, the following menu appears:



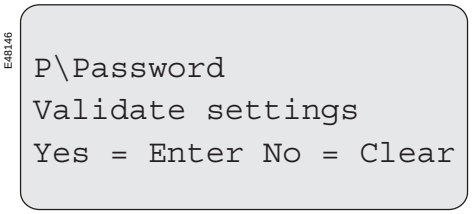
Type the following on the keyboard **6543210** and then press **enter.**
This the password for standard Sepams. If your Sepam has been customized, refer to the documentation provided by your OEM.
To exit from this mode, simply:

- press the **code** key
- wait 2 min after activating any key.

When the pocket terminal is in parameter setting mode, **P** appears on the top left of the screen.

Modification of the password

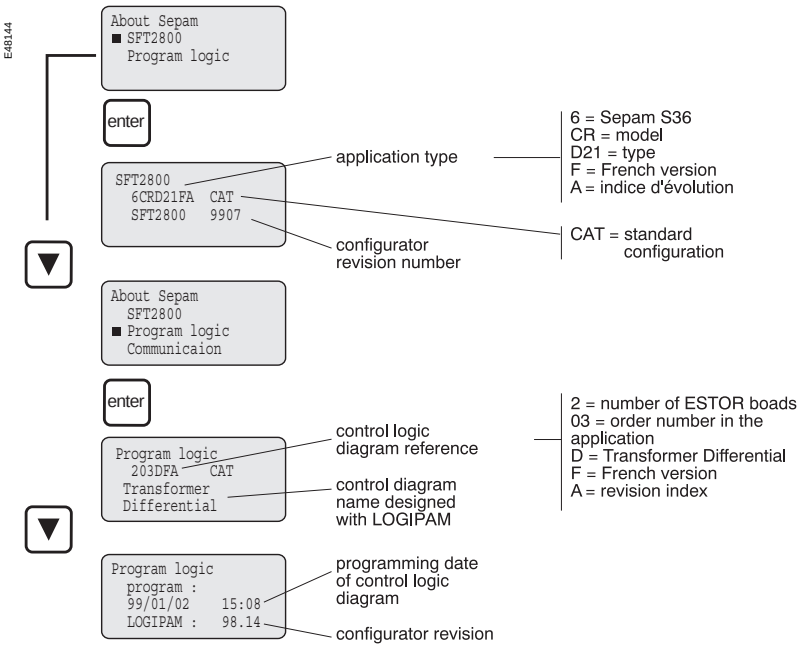
- switch to parameter **Setting** mode and access "Password" in the "Status" menu.
- enter the old password and confirm by pressing "**enter**"
- enter the new password and confirm by pressing "**enter**"
- to check, enter the new password and confirm by pressing "enter"
- confirm again in the window which appears



- choose "**clear**" to cancel all modifications in progress.
- To quit parameter setting mode:
- press the "**password**" key.

Sepam identification using the pocket terminal

Menu: About Sepam:



Current operation

Operation via the pocket terminal

E61747

Function	Pocket terminal menu	Name	Description	Range	Accuracy
Phase current	add. reading I phase	I1 I2 I3	winding 1 current measurement	0 to 24In	± 0.5% at In
		I1' I2' I3'	winding 2 current measurement	0 to 24In	± 0.5% at In
		I1" I2" I3"	winding 3 current measurement (1)	0 to 24In	± 0.5% at In
		dPhi1' dPhi2' dPhi3'	measurement of phase shif between winding 2 currents) and winding 1 currents (2	0 to 360°	± 3° at In
		dPhi1" dPhi2" dPhi3"	measurement of phase shif between winding 3 currents and winding 1 currents (2) (1)	0 to 360°	± 3° at In
Neutral point current	add. reading I phase	Io	measurement of winding 1 neutral point current	0 to 10Ino	± 5% at Ino
	add. reading I' phase	Io'	measurement of winding 2 neutral point current	0 to 10Ino	± 5% at Ino
	add. reading I" phase (1)	Io"	measurement of winding 3 neutral point current	0 to 10Ino	± 5% at Ino
Differential and through currents	add. reading I diff. and I thr.	Id1 Id2 Id3	measurement of diffrential current after phase and amplitude; expressed in winding 1 amps	0 to 24In	± 5%
		It1 It2 It3	measurement of through current after phase and amplitude; expressed in winding 1 amps	0 to 24In	± 5%
		trip Id1 trip Id2 trip Id3	value of differential current at the time of tripping; expressed in winding 1 amps (3)	0 to 24In	± 5%
		trip It1 trip It2 trip It3	value of through current at the time of tripping; expressed in winding 1 amps (3)	0 to 24In	± 5%

(1) *Sepam 2000 D32 only*
(2) *Angles counted in the clockwise direction*
E.g.: for a Yd1 transformer, dPhi 1' = dPhi 2' = dPhi 3' = 30°
(3) *The pocket terminal clear key is pressed to resset currents at the time of tripping.*

Current operation

Event counter

Name	Description	Reset (1)
C2	number of fault trips	KP20

(1) *Requires use of the password*

Annunciation

When an event is detected by Sepam 2000, an operating message appears on the display.
The messages are stored in a list of 16 alarms and may be reviewed in chronological order of appearance, starting with the most recent:

- on Sepam 2000, by pressing the alarm key
- on the pocket terminal, in the program logic menu.

Pressing the reset key will erase the alarms that can be consulted on Sepam 2000. The alarms on the pocket terminal are not erased.

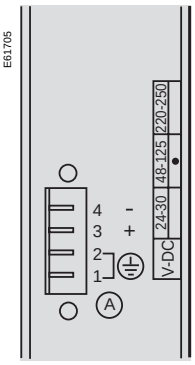
List of messages

Message (1)	Type	Description
DIFF.	P	differential protection tripping, percentage setting
REF 2 (2) ou REF	P	restricted earth fault protection tripping, winding 2
REF 3 (2)	P	restricted earth fault protection tripping, winding 3
BUCHHOLZ (3)	C	buchholz, alarm or tripping
TR TEMP. (3)	C	thermostat, alarm or tripping
AUX.1 (3)	C	auxiliary 1, alarm or tripping
AUX.2 (3)	C	auxiliary 2, alarm or tripping
EXT TRIP (2)	C	external tripping
COUPL. TEST	T	differential protection parameterized in test mode
INHIBIT.	T	inhibition of alarm and tripping outputs
INHIB.OPG	T	locking, disturbance recording tripping
CONNECTOR	M	connector unplugged
CARTBRIDGE	M	cartridge and Sepam not compatible
MAINTENANCE	M	internal Sepam fault
M.CARTRIDGE	M	internal cartridge fault

P = protection
C = control and monitoring
M = maintenance
T = test
(1) *If your Sepam 2000 has been customized, other messages may appear. Please refer to the information package supplied by your OEM.*
(2) *Sepam 2000 D32 only.*
(3) *Sepam 2000 D22 only.*

Checking prior to commissioning

These operations must be carried out before Sepam 2000 is energized.

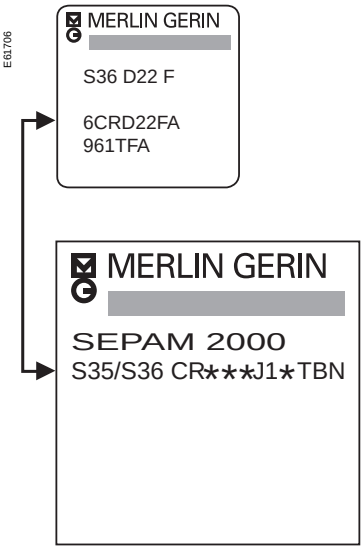


Supply voltage

Ensure that the cubicle auxiliary supply voltage matches Sepam 2000's operating voltage. It is indicated on the rear of the device, beside the power supply connector, by a dot in the voltage box.

Earthing

Check that the Sepam 2000 chassis is earthed by the grounding nut situated on the Sepam side panel, on the power supply side. Check that the screw has been tightened.

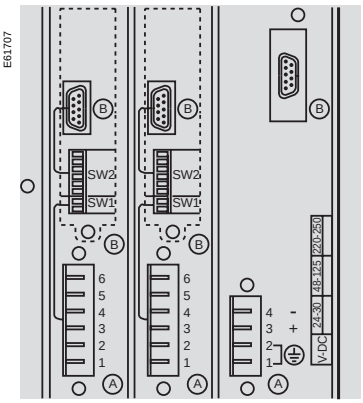


Cartridge

Check that the cartridge is in its slot behind the front wicket door. To do so, open the door by pulling on the notch situated on the left side panel. Sepam S36 has a shield on the right, which resembles the memory cartridge door. This shield is not another door; do not try to open it. Check, by hand, that the 2 threaded screws have been tightened.
Do not plug in or unplug the cartridge while Sepam 2000 is energized.

The cartridge has an identification label on the front. The characters in the second line of the label indicate the type of Sepam 2000. Ensure that the type matches the Sepam 2000 model indicated on the side of Sepam 2000.

Example
CR (resp. CC) on the cartridge label should match CR (resp. CC) on the Sepam 2000 label.



Setting of microswitches on rear

Check that the microswitches which define operating modes and Sepam calibration operations were correctly set at the time of installation (1).

The microswitches must be set with Sepam de-energized
If the microswitches are incorrectly set, the measurements given by Sepam 2000 will be false and the protections will not trip at the required set points.

Connector

Check that all the connectors are correctly connected to the rear of the device and screwed in.

(1) *See"Installation" chapter.*

Commissioning using the TSM 2001 pocket terminal

Switch on the Sepam

When switched on, Sepam 2000 automatically performs the following sequence, which lasts for about 5 seconds:

- green "**on**" and red indicators on
- beep sound (if the pocket terminal is connected)
- red indicator switches off
- setting of watchdog contact
- testing of display units: 0.0.0.0.0.0.0.0.0.0. then **********, then ----------.

After start Sepam 2000 starts up, check that there are no messages present by pressing the "alarm" key.

Checking mode

All information may be accessed for checking purposes without the risk of changing parameters and settings.

Parameter setting mode (1)

This mode is reserved for commissioning and maintenance.
The entry of a password is required.
P appears at the top left of the screen (2).

Parameterization and setting errors

Changing a **status** parameter may put a protection setting outside the tolerance range.
Sepam 2000 detects this problem and displays the following message:

E51985

```
P\ CT ratio
protection setting
out of range
press clear
```

The user should then check and, if necessary, change the protection settings.
The **PROTECTION** line blinks until the settings have been corrected.
Settings out of range.
A protection value may be out of range when it is set.
Sepam 2000 detects this and indicates the permissible range of settings.

E51984

```
P\ DIFF.TRANS F601
Id/It out of range
15% < Id/It < 50%
press clear
```

All the parameters and settings are available in 4 menus:

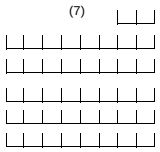
- general parameters: **status** menu
- protections: **protection** menu
- operating parameters: **program logic** menu
- commissining and operating assistance measurements: **add. reading** menu.

(1) *All parameters and settings must be based on a network discrimination study that is to be carried out prior to commissioning.*

(2) *This mode is automatically cancelled if no keys are pressed for about 2 min. It may be cancelled manually by pressing the* ***Code*** *key.*

Parameter and protection settings

Status menu parameter chart

Heading	Name	Function	Command	Selection
Frequency	Fn	network frequency	data + and - keys	50 or 60 Hz
Phase CT ratio	In	CT rating winding 1	numeric keys	adjustable from 10 A to 6250 A (4)
Phase CT'	In	CT rating winding 2	numeric keys	adjustable from 10 A to 6250 A (4)
Phase CT" (1)	In	CT rating winding 3	numeric keys	adjustable from 10 A to 6250 A (4)
Io sensor	sensor	type of neutral point current measurement winding 1	data + and - keys	■ sum of 3I ■ 2 A core bal. CT ■ 30 A core bal. CT ■ CT + CSH30 ■ core bal. CT + ACE990 (8)
	Ino	CT rating in the case of CT + CSH30	numeric keys	setting between 1 A and 6250 A
Io' sensor Io" sensor	sensor (6)	type of neutral point current measurement winding 2 (Io') winding 3 (Io")	data + and - keys	■ sum of 3I ■ 2 A core bal. CT ■ CT + CSH30 ■ core bal. CT + ACE990 (8)
	Ino	CT rating in the case of CT + CSH30	numeric keys	setting between 1 A and 6250 A (4)
Transformer	sensor'	vector group of winding 2 reference winding 1	numeric keys	0 to 11
	sensor" (1)	vector group of winding 3 reference winding 1	numeric keys	0 to 11
	S	rated power (3)	numeric keys	1 MVA to 999 MVA (5)
	Un	rated power winding 1	numeric keys	220 V to 800 kV
	Un'	rated power winding 2	numeric keys	220 V to 800 kV
	Un" (1)	rated power winding 3	numeric keys	220 V to 800 kV
Disturbance recording (8)	Pretrig	number of periods before triggering event	numeric keys	setting between 1and 85 periods
Communication (2) Jbus/Modbus	speed	transmission speed	data + and - keys	300, 600, 1200, 2400, 4800, 19200, 38400 bds
	adress	Sepam 2000 station number in the network	numeric keys	from 1 to 255
	parity	transmission speed	data + and - keys	even, odd no parity
Time tagging (2)	synchro	type of synchronization used	data + and - keys	via: - network - input I11 or I21
	events	I1 I2 I11 to I18 I21 to I28 I31 to I38 KTS1 to KTS32 KTS33 to KTS64	numeric keys by 8-bit word	(7) 
Password			see paragraph at the end of this chapter	

(1) *Sepam 2000 D32 only.*
(2) *Refer to Jbus/Modbus communication document regarding commissioning of communication.*
(3) *For a 2-winding transformer, S is the tranformer rated power. For a 3-winding transformer, S is the rated power*
(4) *Setting limits: $0.1In \leq Ino \leq 2In$*
(5) *Setting limits for each winding,*

$$0.4 < \frac{S}{\sqrt{3}\ Un\ In} < 10$$

(6) *TC + CSH30 is the recommended value.*
Cor bal. CT + ACE 990 is not opérational.
(7) *0 = not time-tagged,*
1 = time tagged.
All events are set to zero by default.
(8) *Available as of version 9940 of SFT 2800.*

Protection function setting ranges

Display messages	Function	ANSI	Rep	Parameters	Commands	Scope of settings
DIFF.	transformer differential	87 T	F601	Id/It percentage setting	numeric keys	from 15 to 50 % (1)
REF2 (2) or REF	restricted earth fault winding 2	64REF	F651	Iso setting	numeric keys	from 1 A to 5 kA, with the following conditions: from 0.05 In' to 0.8 In' if In' ≥ 20 A, from 0.1 In' to 0.8 In' if In' < 20 A
REF3 (2)	restricted earth fault winding 3	64REF	F661	Iso setting	numeric keys	from 1 A to 5 kA, with the following conditions: from 0.05 In" to 0.8 In" if In" ≥ 20 A, de 0.1 In" to 0.8 In" if In" < 20 A

(1) *Advised setting: for CT of 5P type, Id/It = tr + 15% with tr refers to the variation range of the transformer ratio for CT of 10P type, Id/It = tr + 30%.*
(2) *Sepam 2000 D32 only.*
Refer to the "testing" section for information on protection testing.
For further information on protection function characteristics, refer to the main Sepam 2000 D22 or Sepam 2000 D22 - D32 technical manual.

Control logic and annunciation

Sepam 2000 has a standard program logic which allows operation for most common installations; it can be adapted to suit each application scheme by parameter setting at the time of commissioning.

If the Sepam 2000 program logic is customized, the role of the parameters may be different; please refer to the information package provided by the installer.

Control logic resource chart

Function	Name	Comments
Logic input status	I1, I2 I11 to I38	1 = input supplied 0 = input not supplied
Input relay status	O1, O2 O11 to O34	1 = contact closed 0 = contact open
Internal relay status	K1 to K512	1 = contact closed 0 = contact open
Stored bistable status	B1 to B128	1 = contact closed 0 = contact open
Counter content	C1 to C24	reading
Time delay output status	T1 to T60	adjustable from 50 ms to 655 s using **number** and **unit** keys
Parameters: Latched contacts Temporary contacts Impulse contacts	 KP1 to KP16 KP33 to KP48 KP17 to KP32 KP49 to KP64	 set to 1 or 0 using **data +**and **data -** keys or **number** keys **0** and **1**
Remote control contacts: Latched contacts Impulse contacts	 KTC1 to KTC32 KTC33 to KTC96	 contacts set to 1 or 0 from remote control system
Remote indication contacts	KTS1 to KTS64	contacts set to 1 or 0 in order to be read by a remote control system
Alarms messages	AL1 to AL16	reading of the last 16 control logic messages activated (even if erased from the display)

Connection of logic inputs

ESB	Sepam D22	Sepam D32
I1	auxiliary alarm 1	available
I2	auxiliary tripping 1	external tripping
ESTOR1	**Sepam D22**	**Sepam D32**
I11	reserved for external synchronization	reserved for external synchronization
I12	remote control enable	remote control enable
I13	auxiliary alarm 2	available
I14	auxiliary tripping 2	available
I15	thermostat alarm	available
I16	thermostat tripping	available
I17	buchholz alarm	available
I18	buchholz tripping	available
ESTOR2		**Sepam D32**
I21		available
I22		available
I23		available
I24		available
I25		available
I26		available
I27		available
I28		available

Note (D32 application)
The available inputs can not be all used by a personalized application.

Connection of logic outputs

ESB	Sepam D22	Sepam D32
O1	winding 1 tripping	winding 1 tripping
O2	winding 2 tripping	winding 2 tripping
ESTOR1	**Sepam D22**	**Sepam D32**
O11	alarm: thermostat or buchholz or auxiliary 1 or auxiliary 2	available
O12	winding 1 tripping indication	winding 1 tripping indication
O13	winding 2 tripping indication	winding 2 tripping indication
O14	differential or restricted earth fault protection tripping indication	differential or restricted earth fault protection tripping indication
ESTOR2		**Sepam D32**
O21		winding 3 tripping
O22		winding 3 tripping indication
O23		available
O24		available

Program logic parameters

Parameter setting

Parameter	Function	Sepam D22	Sepam D32
	Tripping control		
KP1 = 0	winding 1 breaker with shunt trip coil	■	
KP1 = 1	winding 1 breaker with undervoltage release coil tripping	■	
KP2 = 0	winding 2 breaker with shunt trip coil	■	■
KP2 = 1	winding 2 breaker with undervoltage release coil tripping	■	■
KP3 = 0	winding 3 breaker with shunt trip coil		■
KP3 = 1	winding 3 breaker with undervoltage release coil tripping		■
	Parameterization of input		
KP5 = 0	inputs I15, I16, I17, I18 (thermostat/buchholz) activated by N/O contact	■	
KP5 = 1	inputs I15, I16, I17, I18 (thermostat/buchholz) activated by N/C contact	■	
KP7 = 0	inputs I1, I2 (auxiliary 1) activated by N/O contact	■	
	inputs I2 (external tripping) activated by N/O contact		■
KP7 = 1	inputs I1, I2 (auxiliary 1) activated by N/C contact	■	
	inputs I2 (external tripping) activated by N/C contact		■
KP8 = 0	inputs I13, I14 (auxiliary 1) activated by N/O contact	■	
KP8 = 1	inputs I13, I14 (auxiliary 1) activated by N/O contact	■	
	Parameterization of outputs		
KP10 = 0	I2 (auxiliary 1) and I14 (auxiliary 2)(2) trip winding 1 breaker (O2 and O13)	■	■
KP10 = 1	I2 (auxiliary 1) and I14 (auxiliary 2)(2) trip winding 1, 2 and 3 breakers (O1 and O2, O12, O13, O21 and O22)(1)	■	■
KP13 = 0	Impulse outputs O1, O2, O12, O13, O21(1), O22(1) (tripping and indication) (set by T1 and T2)	■	■
KP13 = 1	Impulse outputs O1, O2, O12, O13, O21(1), O22(1) (tripping and indication)	■	■
	Maintenance and testing		
KP6 = 1	change to test mode and inhibition of tripping outputs	■	■
KP9 = 1	inhibition of tripping outputs	■	■
KP20 = 1	reseting of fault trip counter	■	■
	Disturbance recording		
KP50 = 1	tripping (inhibition)	■	■
KP51 = 1	unlocking and automatic tripping	■	■
KP52 = 1	unlocking and manual tripping	■	■
	Remote setting		
KP38 = 0	remote setting active	■	■
KP38 = 1	remote setting inactive	■	■

(1) *Sepam 2000 D32 only*
(2) *Sepam 2000 D22 only.*

Time delays

The time delays are factory - set by default to 0.2 s.

Time delay	Function	Sepam D22	Sepam D32
T1	minimum duration of tripping order O1 and indication O12	■	■
T2	minimum duration of tripping order O2 and indication O13	■	■

Utilization of program logic

D22 operation

Function	Command		Annunciation					
	O1 winding 1	**O2 winding 2**	**O11**	**O12 winding 1**	**O13 winding 2**	**O14**	**Message**	**Indicator**
Differential protection	■	■		■	■	■	DIFF.	trip
Restricted earth fault	■	■		■	■	■	REF	trip
Alarm buchholz			■				BUCHHOLZ	trip
Buchholz trip	■	■ (1)		■	■ (1)		BUCHHOLZ	trip
Alarm thermostat			■				TR TEMP	trip
Thermostat trip		■			■		TR TEMP	trip
Auxiliary 1 alarm			■				AUX. 1	trip
Auxiliary 1 trip	■	■ (1)		■	■ (1)		AUX. 1	trip
Auxiliary 2 alarm			■				AUX. 2	trip
Auxiliary 2 trip		■ (1)		■	■ (1)		AUX. 2	trip
Trip output inhibition							INHIBIT.	test (fixed)
Test mode and trip output inhibition							COUPL.TEST	test (fixed)
Test mode and trip output operative							COUPL.TEST	test (blinking)
Sepam connector unplugged							CONNECTOR	
Disturbance recording triggering inhibition							OPG INHIB.	

(1) *According to parameter setting*

Exploitation Sepam 2000 D32

Function	Command		Annunciation						
	O1 winding 1	**O2 winding 2**	**O21 winding 3**	**O12 winding 1**	**O13 winding 2**	**O22 winding 3**	**O14**	**Message**	**Indicator**
Differential protection	■	■	■	■	■	■	■	DIFF.	trip
Restricted earth fault winding 2	■	■	■	■	■	■	■	REF 2	trip
Restricted earth fault winding 3	■	■	■	■	■	■	■	REF 3	trip
External tripping	■	■ (1)	■ (1)	■	■ (1)	■ (1)		EXT TRIP	trip
Trip output inhibition								INHIBIT.	test (fixed)
Test mode and trip output inhibition								COUPL. TEST	test (fixed)
Test mode and trip output operative								COUPL. TEST	test (blinking)
Sepam connector unplugged								CONNTECTOR	
Disturbance recording triggering inhibition								OPG INHIB.	

(1) *According to parameter setting.*

Disturbance recording

Activation of disturbance recording

A new record is activated:

- ■ locally, via the KP52 parameter
- ■ remotely, via the KTC52 remote control order
- ■ automatically, when one of the following protections trips:
- □ differential
- □ restricted earth fault, winding 2
- □ restricted earth fault, winding 3 (Sepam D32 only).

Data recorded

All the analog inputs are recorded a,d the logical states recorded are as follow:

Fonction	Name of logical state	
	D22	D32
Winding 1 tripping	KFR1	KFR1
Winding 2 tripping	KFR2	KFR2
Winding 3 tripping		KFR6
Differential protection	KFR3	KFR3
Restricted earth fault protection, winding 2	KFR4	KFR4
Restricted earth fault protection, winding 3		KFR5

Setting record sheet

Project:	Sepam 2000 differential
Switchboard:	Type of Sepam 2000 D☐☐
Panel:	
.....	Serial number ☐☐☐☐☐☐☐

Status menu parameter

Heading	Name	Function				
Frequency	Fn	Network frequency	☐ 50 Hz	☐ 60 Hz		☐
			Board 2 winding 1	Board 3 winding 2	Board 4 winding 3	
CT, CT',CT" phase	In	CT rating (in Amps)	☐☐☐☐☐	☐☐☐☐☐	☐☐☐☐☐	☐
Io sensor Io' sensor Io" sensor	Ino	Residual current measurement	☐ Sum 3I ☐ Core bal. 2A ☐ Core bal. 30A TC + CSH30 ☐☐☐☐ ☐ A ☐ kA Core bal. CT + ACE990 ☐☐☐☐ ☐ A ☐ kA	☐ Sum 3I ☐ Core bal. 2A ☐ Core bal. 30A TC + CSH30 ☐☐☐☐ ☐ A ☐ kA Core bal. CT + ACE990 ☐☐☐☐ ☐ A ☐ kA	☐ Sum 3I ☐ Core bal. 2A ☐ Core bal. 30A TC + CSH30 ☐☐☐☐ ☐ A ☐ kA Core bal. CT + ACE990 ☐☐☐☐ ☐ A ☐ kA	☐
Transformer	index' index"	Vector group compared to winding 1		☐☐	☐☐	☐
	S	Power	☐☐☐☐☐			
	Un, Un',Un"	Rated voltage	☐☐☐☐☐	☐☐☐☐☐	☐☐☐☐☐	
Disturbance recording	pretrig	Number of periods before triggering event	☐☐ periods			☐
Communication	Address	Sepam station number in network	☐☐☐			☐
	Bauds	Transmission speed (Jbus/Modbus)	☐ 300 ☐ 600 ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200 ☐ 38400			☐
	Parity	Transmission format (Jbus/Modbus)	☐ even ☐ odd ☐ no parity			☐
Time tagging	Synchro	Type of synchronization used	via network		via input I11 via input I21	
Microswitch setting Put an X in a box to indicate switch setting e.g. switch set to right ☐ ☒		ECMD current board	SW2 SW1	SW2 SW1	SW2 SW1	☐ ☐

Program logic parameters

KP	0 ou 1		D22	D32
KP1	☐	winding 1 breaker: undervolt. trip coil	☐	
KP2	☐	winding 2 breaker: undervolt. trip coil	☐	☐
KP3	☐	winding 3 breaker: undervolt. trip coil		☐
KP5	☐	I15, I16, I17, I18 for normally closed contact (NC)	☐	
KP7	☐	I1, I2 for normally closed contact (NC)	☐	☐
KP8	☐	I13, I14 for normally closed contact	☐	
KP10	☐	I2, I14 for tripping winding 1 and 2	☐	☐
KP13	☐	latching outputs	☐	☐
KP38	☐	remote setting disable	☐	☐

Time delay (value)		D22	D32
T1	☐☐☐☐☐ impulse O1 and O12	☐	☐
T2	☐☐☐☐☐ impulse O2 and O13	☐	
T2	☐☐☐☐☐ impulse O2, O13, O21 and O22		☐

KP	0 ou 1 impulsionnel	
KP50	disturbance recording inhibition	☐
KP51	automatic triggering of disturbance recording	☐
KP52	manual triggering of disturbance recording	☐

Protection setting record

Differential		
Id/It	☐☐ % percentage set point	☐
Restricted earth fault, winding 2		
Iso	☐☐☐☐☐ Amps set point	☐
Restricted earth fault, winding 3		
Iso	☐☐☐☐☐ Amps set point	☐

Maintenance

Sepam 2000 comprises self-testing and self-diagnosis to facilitate installation maintenance.

Indicator lamps and display messages

■ Green indicator lamp lit up Sepam 2000 is energized.

■ No indicator lamps lit up.

Check the auxiliary power supply and connections to the CE40 board.
Perform the lamp test.

■ Red lamp indicates internal Sepam 2000 faults.
Sepam continuously performs on-line internal tests. When the test results are negative, Sepam 2000 automatically runs a series of sequences which result in either:
□ automatic reinitialization (minor fault, e.g. transient auxiliary power supply break). Sepam 2000 carries out a complete restart sequence. If restart is successful, Sepam 2000 operates again normally. All the output relays are de-energized (1),
□ switching to the fail-safe position. All the output relays drop out (1) in order to avoid inadvertent commands, and the watchdog drops out as well.

The following may cause internal faults:
■ Missing cartridge:
□ red indicator lamp lit up
□ display OFF
□ no dialogue with pocket terminal
□ no dialogue with communication link
□ watchdog dropped out
□ switching to fail-safe position.
Sepam 2000 will not start, lacking a program: this is a major fault.

■ Configuration fault:
□ red indicator lit up
□ red lamp indicates **CARTRIDGE**
□ no dialogue with the pocket terminal
□ no dialogue with the communication link
□ the watchdog is dropped out
□ switching to fail-safe position
□ Sepam 2000 is shut down: this is a major fault

Check whether the type of cartridge with the type of Sepam 2000.

Caution: do not insert or remove the cartridge while Sepam is energized.
Disconnect the auxiliary power supply and wait 2 seconds before handling the cartridge

Check the references on the Sepam 2000 and on the cartridge
(refer to chapter on Sepam identification).

■ Other major faults:
□ Red indicator lit up
□ display indicates **MAINTENANCE** or **CARTRIDGE** or **MCARTRIDGE**
□ no dialogue with the pocket terminal
□ no dialogue with the communication link (if the CPU is faulty)
□ the watchdog is dropped out
□ switching to the fail-safe position. Sepam 2000 is shut down: this is a major fault

Consult your maintenance department.

(1) *This may cause tripping with undervoltage control logic ("fail-safe" logic) ("fail-safe" logic scheme).*

Maintenance

Indicator lamps and display messages (cont'd)

■ Minor or partial faults:
□ red indicator extinguihed
□ display indicates **MAINTENANCE** or **CARTRIDGE**
□ dialogue with the pocket terminal is maintained
□ dialogue with the communication link is maintained
□ the watchdog does not drop out
□ switching to the fail-safe position.

Sepam 2000 is operating, however it has detected a transient fault or has failed to pass self-testing.

Consult your maintenance department.

■ The display indicates: **CONNECTOR**
Indication that one or more connectors are unplegged.

Check the plugging in and screwing on of the connectors on the rear of the device.
Check that the DPC has been strapped on all the connectors.

Communication indicator lamps

These lamps are located at the rear of the device on the CE40 module when the module is equipped with the communication option.

■ Green indicator lamp blinking: indicates traffic on the line.
This is the normal operating mode.

■ Indicator lamps extinguished: there is no communication.

Check the parameters and settings.

■ Red indicator lamp lit:
indicates initialization of the coupler, which lasts about 2 seconds, or a coupler fault.

Consult your maintenance department.

■ Red indicator lamp lit up and the recommendations given in the maintenance chapter do not allow Sepam 2000 to be restarted.

Call in the maintenance department.

Unwanted tripping, no tripping

Incorrect parameter setting may cause unwanted tripping or no tripping. All of the parameters and settings must be based on the network discrimination study to be carried out prior to commissioning.

Check the parameters and settings.

Tests

Lamp test: when the user presses the - **lamp test** - keys at the same time, all the indicators on the front of the device light up, as well as the display which alternately indicates 0.0.0.0.0.0.0.0.0.0 then **********, then ----------.

Sepam replacement

When Sepam 2000 is replaced:
■ dismantle the Sepam 2000 to be replaced
■ retrieve the cartridge
■ mount the Sepam replacement (hardware configuration)
■ install the cartridge
■ check the compatibility between Sepam and the cartridge
(see chapter on "identification")
■ set microswitches SW1 and SW2 on the rear of the device in the same positions as they were in on the Sepam 2000 that was replaced
■ install the connectors, checking their markings
■ energize Sepam.

Contents

Characteristics **3/2**

Output relays characteristics **3/3**
Output relays of ESB and ESTOR boards manufactured prior to 1.1.2000. 3/3
Output relays of ESB and ESTOR boards manufactured as of 1.1.2000. 3/3

Dependability **3/4**
Definitions 3/4
Consideration of dependability in Sepam 2000 3/4
Dependability needs: a trade-off between two unwanted events 3/4
Self-monitoring functions and fail-safe position 3/4

Autotests **3/5**
Sepam 2000 functional diagram 3/5
List of Sepam 2000 self-tests 3/5

Qualification tests **3/6**
Electrical tests 3/6
Performance tests in reference conditions 3/6
Testing of output effects in rated domains 3/6
Effects of the equipment on the environment 3/6
Effects of the environment on the equipment 3/6
Reference documents 3/6

Electrical tests **3/7**
Aim 3/7
Preliminary operating test 3/7
Grounding continuity 3/7
Insulation testing 3/7
Dielectric strength 3/7
Impulse wave withstand 3/7
Power supply circuit robustness 3/7

Performance tests in reference conditions **3/8**
Aim 3/8
Checking of parameter specifications 3/8
Miscellaneous 3/8

Testing of output effects in rated domains **3/9**
Aim 3/9
Analog input circuits 3/9
DC power supply 3/9
Logic input circuits 3/9
Logic output circuits 3/9
Ambient temperature 3/9

Effects of the environment on the equipment **3/10**
Aim 3/10
Sensitivity to electromagnetic interference 3/10
Climatic and mechanical robustness tests 3/10

Effects of the equipment on the environment **3/12**
Aim 3/12
DC power supply 3/12
Radiofrequency interference 3/12

Reference documents **3/13**
Standards 3/13

Characteristics

Sepam 2000 logic inputs					
Connection	by 0.6 to 2.5 mm² wire to CCA 621 (CCA 621)				
According to Sepam 2000 power supply	24/30 Vdc	48/127 Vdc	220/250 Vdc		
Consumption	4 mA	4 mA	3 mA		
Level 0	< 6 V	< 25.4 V	< 50 V		
Level 1	> 17 V	> 33.6 V	> 154 V		
Permissible steady state overload	36 V	152 V	275 V		
Pick up time	10 ms	10 ms	10 ms		
Insulation	2 kV	2 kV	2 kV		
Sepam 2000 output relays					
Connection	by 0.6 to 2.5 mm² wire to CCA 621 terminal				
Making capacity	15 A				
400 ms overload	15 A				
Steady state current	8 A				
Number of switching operations	10 000 at full load				
Contact/coil insulation	2 kV rms				
Breaking capacity	48 Vdc	125 Vdc	200/250 Vdc		
DC with resistive load	4 A	0.8 A	0.3 A		
DC at L/R = 20 ms	2 A	0.4 A	0.15 A		
DC at L/R = 40 ms	1 A	0.2 A	0.1 A		
AC with resistive load	8 A	8 A	8 A		
AC with p.f. = 0.3	5 A	5 A	5 A		
Phase current inputs for 1 A or 5 A CT					
Phase current inputs for 1 A or 5 A CT	by 4 mm eye lugs, to CCA 660 or CCA 650 connector (connector with incorporated CTs) disconnectable on line				
Wire cross-section	6 mm² maxi				
Input impedance	< 0.001 Ω				
Power consumption	< 0.001 VA for 1 A				
Steady state thermal withstand	3 In				
1-second overload	80 In				
Operating range	up to 24 In				
CCA 660 or CCA 650 dielectric insulation	2 kV rms 1 min. (4) - IEC 60255-5				
Input for earth current measurement with 1 A or 5 A CT					
Connection	by 0.6 to 2.5 mm² wire, to CCA 606 screw terminal pad				
Input impedance	< 4 Ω				
Power consumption	< 0.1 VA				
Steady state thermal withstand	10 x core balance CT rating (6)				
1-second overload	500 x core balance CT rating (6)				
Operating range	10 x core balance CT rating (6)				
Insulation	input not insulated from earth (5)				
Jbus/Modbus communication input					
Connection	cable (CCA 602 or CCA 619 accessory)				
Transmission	asynchronous serial				
Protocol	Jbus/Modbus slave				
Electrical interface	according to EIA- RS 485 standard				
Maximum distance without repeater	1200 m				
Number of Sepam 2000s on the line	31 maximum				
Rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bits/s				
Insulation	1 kV rms				
Power supply					
Connection	by 0.6 to 2.5 mm² wire to CCA 604 terminal				
Dielectric insulation	2 kV rms 1 mn				
Tension voltage	24/30 Vdc	48/127 Vdc	220/250 Vdc	100/127 Vca	220/240 Vca
Permissible variations (3)	-20% to +20%	-20% to +20%	-20% to +10%	-20% to +20%	-20% to +10%
Consumption on power supply circuit (1)	24 Vdc	48 Vdc	127 Vdc	220 Vdc	
Inrush current	5 A/0.2 s	1 A/0.5 s	1.5 A/0.5 s	1 A/.2 s	
Consumption all relays deactivated	0.6 A	0.28 A	0.12 A	0.08 A	
Consumption all relays activated	1 A	0.6 A	0.22 A	0.13 A	
Weight (2)	**minimum**	**maximum**			
Sepam S36	8 kg	10.5 kg			

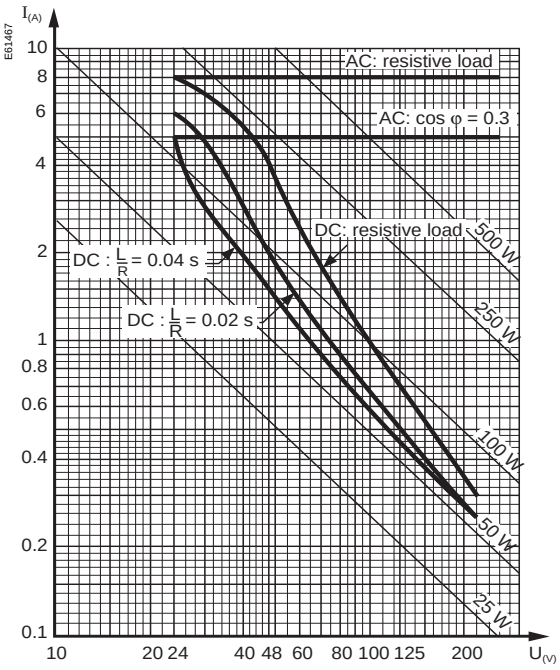
***(1)** The figures are given for:*
- *Jbus/Modbus coupler option included (Subtract 1 W for Sepam 2000 without communication)*
- *clain pocket terminal not connected (Add 1/2 W if the pocket terminal is connected)*
- *Sepam S36 equipped with 3 ESTOR boards.*

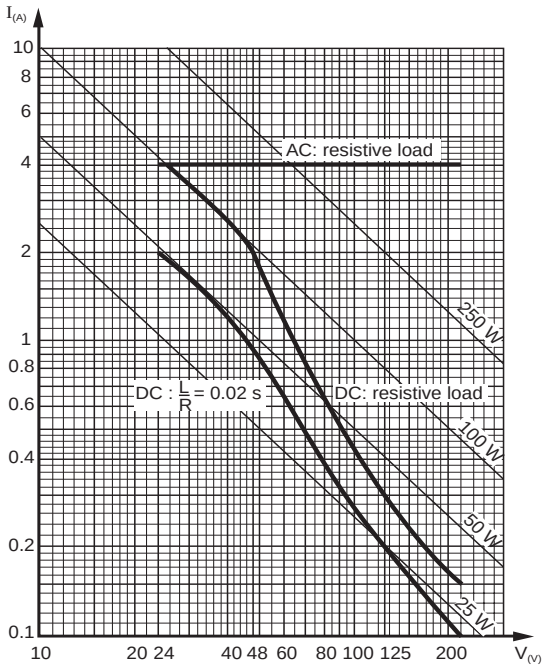
***(2)** The figures give the weight according to the number of options for each model.*
***(3)** Correct operation of Sepam 2000 is only guaranteed within these ranges.*
this refers to the isolation procured by the CCA 660 core balance CT connector. The Sepam 2000 input on the sub-D connector is not isolated from the earth.
***(5)** This refers to the Sepam 2000 input. The CSH 30 primary, for its part, is isolated from the earth.*
***(6)** Expressed as CT primary current.*

Output relays characteristics

Output relays of ESB and ESTOR boards manufactured prior to 1.1.2000.

- ref. ESB24/30V: 3124217
- ref. ESB48/125V: 3122347
- ref. ESB220/250V: 3124287

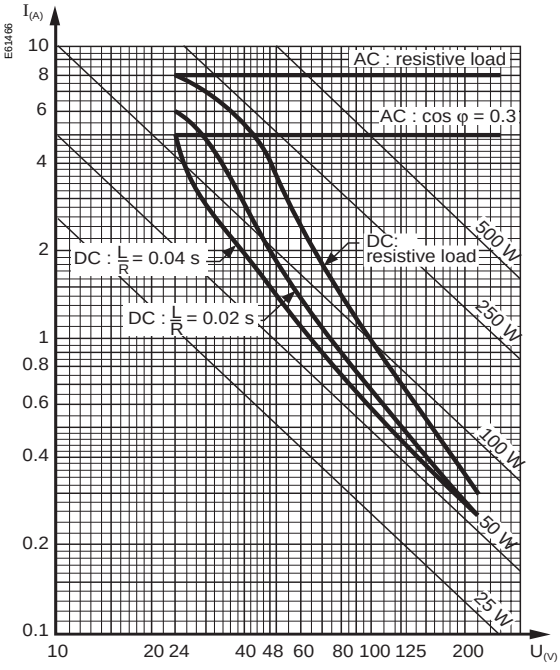




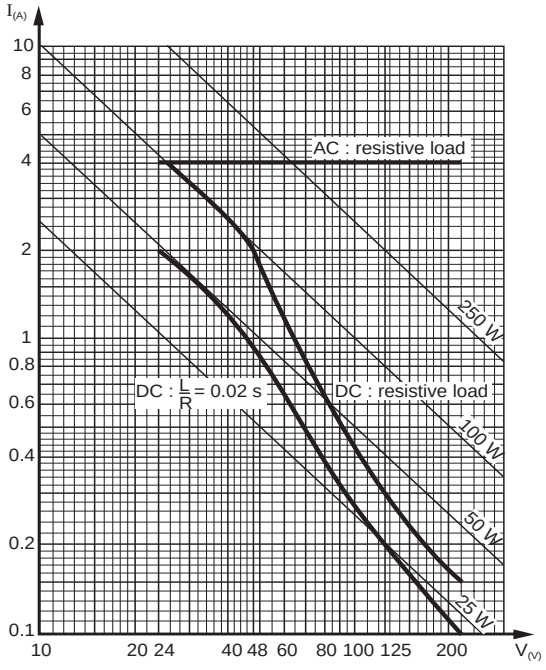
- Sepam 2000 output relay: O1, O2, O11 to O14, O21 to O24, O31 to O34 contacts.

Output relays of ESB and ESTOR boards manufactured as of 1.1.2000.

- ref. ESB24/30V: 03145141FA
- ref. ESB48/125V: 03145347FA
- ref. ESB220/250V: 03145149FA
- ref. ESTOR24/30V: 03145157FA
- ref. ESTOR48/125V: 03145161FA
- ref. ESTOR220/250V: 03145165FA



- Sepam 2000 output relay: O1, O2, O11 to O14, O21 to O24, O31 to O34 contacts.



- Sepam 2000 "watch dog" output.

Dependability

This chapter presents the main definitions of dependability and how it is taken into consideration in Sepam 2000, an analysis of the experience gained from feedback on the installed equipment base and the maintenance of Sepam 2000.

Definitions

The definitions which follow are the main definitions of dependability applied to protective devices:

■ The reliability of a protective device is its capability of performing its function (or functions) over a given period of time in the operating conditions specified by the manufacturer, i.e. mainly the capability of tripping when required and the capability of not tripping when unwanted.

■ The availability of a protective device is its capability of being in a state to perform its function (or functions) at a given point in time in the operating conditions specified by the manufacturer.

These values do not necessarily have the same meanings, depending on whether they are considered from the viewpoint of the protective device or the electrical installation.

■ The availability and maintainability of the protective device contribute to the safety of people and equipment. The reliability of the protective device contributes to the uninterrupted availability of the power supply.

Dependability needs: a trade-off between two unwanted events

The mission of protection systems used with circuit breakers is to guarantee the safety of the installation while, at the same time, ensuring the best level of interrupted power supply.

For Sepam 2000, this mission is conveyed by two events, the target occurrence of which should be zero.

■ First unwanted event:

unwanted tripping of the protective device.

An uninterrupted power supply is essential for both industrialists and utilities. Unwanted tripping due to the protective device is liable to generate substantial financial losses. This event can be avoided by improving the reliability of the protective device.

■ Second unwanted event:

failure of the protective device to trip.

The consequences of a fault that is not cleared are liable to be disastrous. For the sake of operating safety, the protective equipment must detect power system faults selectively and as quickly as possible.

This event can be avoided by improving the **availability** of the protective device.

Consideration of dependability in Sepam 2000

By the same token as electromagnetic compatibility, dependability is taken into consideration right from the start of the development of Sepam 2000.

A Preliminary Risk Analysis (PRA) is used to list the unwanted events linked to the different functions performed by Sepam. Quantified dependability targets are set in accordance with the main unwanted events revealed by the PRA.

Specialized dependability assessment and modeling techniques are used to interpret the targets in terms of design requirements.

■ The predicted reliability analysis determines the failure rate of each Sepam 2000 component in use-related conditions. Compendiums of reliability data such as the Military Handbook 217 (MIL HDBK 217) and the CNET RDF93 are used for this.

■ The Failure Modes, Effects and Criticality Analysis (FMECA) analysis is used to analyze the effects of a simple component failure on the Sepam 2000 functions and to list the means available to detect them. The FMECA makes it possible to correct certain risks of malfunctions and specify the self-monitoring functions.

■ The unwanted events are modeled to calculate the probability of their occurrence and to check that the dependability targets are being met.

■ A large share of the functions of digital protective equipment devices are performed by the software. It is therefore essential to master the quality of the software in order to attain the overall dependability targets. Software quality is mastered by the implementation of a rigorous development method.

■ This method is derived from the recommendations set by the French (AFCIQ) and international (IEEE) quality authorities. It stipulates:

□ the breakdown of development into a series of phases

□ the use of design and encoding rules and methods aimed at achieving a high level of software structuring

□ the use of software configuration management tools which allow all the software component parts to be managed.

Self-monitoring functions and fail-safe position

Sepam 2000 units are equipped with self-monitoring functions (self-tests), which detect internal failures. The failures are classified in two categories: major failures and minor failures.

■ A **major failure** affects the system's common hardware resources (e.g. program memory and working memory).

Sepam 2000 is no longer operational. This type of failure may or may not lead to MV fault tripping or unwanted tripping, in which case Sepam 2000 must react quickly and go into the fail-safe position.

The fail-safe position is characterized by:

□ lockout in neutral position of the Processing Unit

□ an indicator lit up on the front of the device

□ a message on the display

□ the Watchdog relay in fault position (deactivated)

□ the relay outputs (logic outputs) in the deactivated position

□ a break in the relay output supply for Sepam S46.

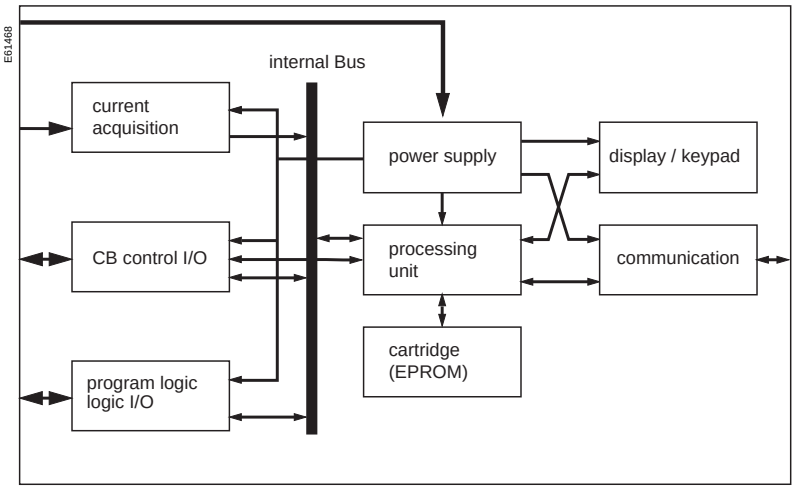
■ Following a **minor failure**, Sepam 2000 is in downgraded operation.

It can continue to carry out all of its protection functions if the functions affected are peripheral ones (display, communication).

This classification of failures makes it possible to obtain a compromise between between a high level of safety and a high level of availability. The self-tests performed in Sepam 2000 are summarized in the diagram on the next page.

Autotests

Sepam 2000 functional diagram



List of Sepam 2000 self-tests

Functions	Type of self-test	Execution periodicity	Fail-safe position
Power supply	detection of processor supply out of range detection	continuously	YES
	of a drop in supply voltage		YES
Current acquisition	detection of analog channel saturation current channel	continuously	YES
	consistency check		YES
CB control inputs/outputs	output relay supply checking Input / Output (I/O)	switching on	YES
	control tests checking of output status	and continuously	YES
Logic inputs / outputs	program logic output relay supply checking	switching on	YES
		and continuously	YES
Processing unit		switching on and:	
	CPU test	continuously	YES
	working memory test	periodically	YES
	signal selector & signal digitization test	continuously	YES
	measurement acquisition test	continuously	YES
	hardware & cartridge software consistency test	periodically	YES
	software watchdog	continuously	YES
	(limited time allocation to each function)		
Cartridge		switching on and:	
	cartridge present test	continuously	YES
	memory test	periodically	YES
	number of entries in parameter backup memory test	continuously	NO
Display	memory test	switching on	NO
	display CPU test	and periodically	NO
Communications		switching on and:	
	memory test	periodically	NO
	communication CPU test	periodically	NO
	monitoring of dialogue with processing unitcontinuously	continuously	NO

Qualification tests

This chapter presents the main specified properties (mechanical, electrical, functional, etc...) that are verified during the qualification tests carried out in the factory ("manufacturer" tests).
It describes:
- *the content of each test*
- *the standards and reference documents*
- *the expected results*

It is divided into 5 sections, grouping together the different items involved in product qualification by theme:

Electrical tests
Tests related to the protection of people and equipment (grounding continuity, insulation, fuses…).

Performance tests in reference conditions
Verification of special functional features (hardware and software) of the product when used in the "reference environment" (i.e. temperature, power supply… using strict tolerances).

Testing of output effects in rated domains
Examination of the rated operating domain (input signals, output loads, power supply...), using one variable at a time.

Effects of the equipment on the environment
Testing of interference (electromagnetic, mechanical...) generated by the product.

Effects of the environment on the equipment
Testing of the product's sensitivity and/or resistance to electromagnetic, mechanical, chemical... interference.

Reference documents
In order to facilitate reading, only documents of prime importance are succinctly referenced in each test description.

Electrical tests

Aim

The aim of these tests is to test the effectiveness of the measures taken to protect people and equipment.

Preliminary operating test

Aim: to ensure the integrity of the item being tested (the test procedure allows the device, its integrated components and remote functions to be tested at the same time).

N.B. The test is not exhaustive. It is merely aimed at providing a good "macroscopic" view of the item before and/or after the application of potentially destructive stress, in a minimal test environment.

Grounding continuity

Aim: to test the continuity of grounding protection.
Reference documents:
standards: IEC 61131-2
Severity: polarizing current: 30 A.
Acceptance criterion: R < 0.1Ω.

Insulation testing

Measurement of insulation resistance
Aim: to test the constructive integrity of the item before dielectric stress is applied.
Reference documents:
standards: IEC 60255-5
Special conditions: measurement is performed in both common and differential modes.
Severity: applied voltage: 500 VDC
Acceptance criterion: $R_i \geqslant 100$ MΩ.

Dielectric strength

Aim: to ensure that the dielectric strength of the insulation complies with specifications.
Reference documents: standards: IEC 60255-5
Acceptance criteria:
During the test:
- no breakdowns, perforations, warping

After the test:
- the device must correspond to all of its functional specifications.

Severity:

Circuits	Test voltage	
	Common mode	**Differential mode**
Power supply	2 kVrms/50 Hz	N/A
Logic inputs	2 kVrms/50 Hz	N/A
Analog inputs	2 kVrms/50 Hz	N/A
Logic outputs	2 kVrms/50 Hz	1 kVrms/50 Hz(*)
Setting terminal socket	0.5 kVrms/50 Hz	N/A

(*) With contacts open

Impulse wave withstand

Aim: to ensure that the device is capable of withstanding high overvoltage for very short periods of time without any damage.
Reference documents: standards: IEC 60255-5
Acceptance criteria:
During the test:
- no breakdowns, performations, warping

After the test:
- the device must correspond to all of its functional specifications.

Severity:

Circuits	Test voltage	
	Common mode	**Differential mode**
Power supply	5 kV	5 kV
Logic inputs	5 kV	5 kV
Analog inputs	5 kV	5 kV
Logic outputs	5 kV	N/A
Pocket terminal socket	1 kV	0.5 kV

Power supply circuit robustness

Short-circuit current behaviour
Aim: to ensure that the device's circuits are capable of withstanding, without damage, stress caused by short-circuit currents resulting from internal failures.
Acceptance criteria:
During the test:
- short-circuit current less than 15 A for a maximum of 20 ms
- effectiveness of protective devices

After the test:
- visual check of cabling, connectors, printed circuit paths
- return to normal operation after resetting or replacement of the protective devices.

Polarity reversal behaviour
Aim: to ensure that the device is capable of withstanding, without damage, an accidental power supply polarity reversal.
Reference documents: standards: IEC 61131-2.
Severity: operation for at least 10 seconds with the power supply polarities reversed.
Acceptance criterion:
Return to normal operation after the power supply polarities have been correctly re-established.

Performance tests in reference conditions

Aim

The aim of these tests is to test the special functional features (hardware and software) of a device in its "reference environment", i.e. temperature, power supply, etc., using strict tolerances.

Checking of parameter specifications

Aim: to check conformity of input/output interfacing characteristics.

Analog input circuits
Compostion of tests
For each type of input (sensors, process, etc.), minimum testing includes:
- dynamics and accuracy (examination of the rated domain)
- input impedance (examination of the rated domain)
- passband.

Logic input circuits
Composition of tests
For each type of input (static relay, etc.), minimum testing includes:
- input impedance (exploration of rated domain)
- thresholds (high, low, hysteresis)
- minimum set-up time (high and low levels).

Logic output circuits
Composition of tests
For static type outputs, minimum testing includes:
- output dynamics (I or V)
- output compliance (I or V)
- influence of load (transition time, over/undershoots)
- for datacom: protocol, frequency, gigue, etc.

For relay type outputs, minimum testing includes:
- breaking capacity (min.-max. I/V, load impedance)
- bounce time.

Miscellaneous

Initialization
Aim: to verify the efficiency of self-testing carried out by the device during start-up.

Downgraded operation
Aim: to verify the efficiency of self-testing carried out by the device while functioning.

Module interchangeability
Aim: to test maintenance capability.
Comments: the tests include:
- power source converter
- core-connector.

Testing of output effects in rated domains

Aim

These tests verify the operation of the device in the rated domain of input signal variations, output loads, power supply voltage, etc.
One degree of freedom is variable for each test, the other values being kept at their reference values.

DC power supply

Reference documents:
standards: IEC 60255-22-xx, IEC 61131-2
for determination of sensitivity limits.

Voltage amplitude
Aim: to test the device's ability to function with all acceptable power supply voltages.

Alternating component
Aim: to test the device's ability to function with an alternating component (rectifier-battery charger) superimposed on its DC supply voltage.
Severity: alternating component (= ripple battery voltage) with frequency >100 Hz and peak-to-peak amplitude = 0.12 Unom
Comments: the test is performed:
■ at the extreme limits of the power supply domain.

Fading cancellation
Aim: to check the device's ability to maintain operation in spite of power supply micro-outages (source changeover or faulty device nearby).
Severity: 10 voltage outages, at minimum 1 sec. intervals, lasting:
75 ms for Vpower = Vnom
30 ms for Vpower = Vmin
Comments: the voltage outages correspond:
■ first, to an opening in the power supply line (infinite impedance during disturbance),
■ then, to a shorting of the power supply line (zero impedance during disturbance).

Accidental voltage surges
Aim: to test the device's ability to maintain operation in the presence of transient surge voltage in the power supply (handling shocks, reactive load switching).
Severity: 10 surges, at minimum 1 sec. Intervals, lasting 10 ms, with a maximum slope of 100 V/ms, and maximum amplitude:
+ 20 V for Un < 48 V,
+ 40 V for Un > 48 V.

Analog input circuits

Reference documents:
standards: IEC 60255-6 , IEC 61131-2

Composition of tests:
for each type of input (sensors, process, etc.), testing includes, in particular:
■ behaviour at limits (saturation, voltage limiter operation)
■ input currents/voltages when saturated
■ passband / recovery time
■ permissible overload and dynamic thermal limit for sensor inputs.

Logic input circuits

Reference documents:
standards: IEC 60255-6, IEC 61131-2

Composition of tests:
testing includes, in particular:
■ static inputs
□ input dynamics (examination of saturation)
□ input currents/voltages (examination of saturation)
■ relay type inputs
□ maximum permissible voltage
□ input impedance (voltage limiters, R.L. diodes)
□ resolution (min. duration of a single-shot input signal)
□ maximum frequency.

Logic output circuits

Reference documents:
standards: IEC 60255-6, IEC 61131-2

Composition of tests:
Testing includes, in particular:
■ static outputs
□ effectiveness of protective devices
□ maximum length of datacom link
■ relay type outputs
■ effectiveness of protective devices (damping circuits, overvoltage suppressors).

Ambient temperature

Aim: to confirm the hypothesis of temperature rise of the device when being cooled by natural air convection in a confined area.
Reference documents:
standards: IEC 60068-2-2
Comments: this test is complementary to the standardized test described in the section on "dry heat".

Effects of the environment on the equipment

Aim

These tests check device sensitivity and resistance to electromagnetic, mechanical, chemical, etc. interference.

Reference documents:
standards: IEC 60255-22-xx for determination of sensitivity limits.

Sensitivity to electromagnetic interference

Sensitivity to conducted interference

1MHz damped wave
Aim: to test that the device does not operate in an unwanted manner when subjected to high frequency transients (switching of auxiliary relays or isolation switches/circuit breakers).

Reference documents:
standards: IEC 60255-22-1

Severity

Circuits	Test voltage	
	Common mode	Differential mode
Power supply	2.5 kV	1 kV
Logic inputs	2.5 kV	1 kV
Analogic inputs	2.5 kV	1 kV
Logic outputs	2.5 kV	1 kV

Fast transient bursts
Aim: to test device immunity when subjected to rapid, repeated electrical transients (inductive load breaks, relay contact bounces).

Reference documents:
standards: IEC 60255-22-4

Severity

Circuits	Test voltage (coupling)	
	Common mode	Differential mode
Power supply	4 kV [direct]	4 kV [direct]
Logic inputs	4 kV [direct]	4 kV [direct]
Analogic inputs	4 kV [direct]	2 kV [direct]
Logic outputs	4 kV [direct]	4 kV [direct]
Pocket terminal socket	4 kV [capacitive]	

Sensitivity to radiated interference
Aim: to test that the device does not operate in an unwanted manner when subjected to an electromagnetic field of radiation (especially transmitters/receivers).

Reference documents:
standards: IEC 60255-22-3, IEC 61000-4-3

Severity:
intensity of field: 30V/m not modulated
10V/m amplitude-modulated.

Impulse wave
Aim: to test the device's immunity when it is submitted to transients caused by lightning and switching (capacitor bank, short-circuit to earth, etc.).

Reference document:
standard: IEC 61000-4-5

Severity

Circuits	Test voltage (test impedance)	
	Common mode	Differential mode
Power supply	2 kV (42 Ω)	1 kV (42 Ω)
Logic inputs	2 kV (42 Ω)	1 kV (42 Ω)
Analogic inputs	2 kV (42 Ω)	1 kV (42 Ω)
Logic outputs	2 kV (42 Ω)	1 kV (42 Ω)
Earth fault current input TC + CSH30	2 kV (42 Ω)	1 kV (42 Ω)
Communication interface	2 kV (42 Ω) on shielding	N/A

Sensitivity to electrostatic discharges
Aim: to test that the device does not operate in an unwanted manner when subjected to electrostatic discharge (operator contact or nearby objets).

Reference documents:
standards: IEC 60255-22-2

Severity:
generator load voltage: 8 kV in air
6 kV on contact

Testing in a simulated MV environment
Aim: to check that there is no nuisance tripping during MV switchgear operations.
Composition of tests: device installed in a cubicle shunt-wired to a high voltage generator.

Severity:
generator voltage: 30 kV / 50Hz.
Number of operations: 30 closing operations.

Climatic and mechanical robustness tests

Foreword: Test sequence
- the same device undergoes all the tests
- the sequential testing order complies with the recommendations

in the IEC 60068-1 standard (as testing order maximizes the significance of the results, each test potentially reveals deterioration caused by previous tests).

Cold
Aim: to test the device's ability to be used at low temperatures.

Reference documents:
standards: IEC 60068-2-1

Severity:
Ad test, without forced air circulation:
- device in operation,
- temperature: 0 °C,
- duration: 16 hours,
- recovery: 1 hour, device energized.

Nota : *the pocket terminal is not subjected to the tests.*

Dry heat
Aim: to test the device's ability to be used at high temperatures.

Reference documents:
standards: IEC 60068-2-2

Severity:
Bd test, without forced air circulation:
- device in operation
- temperature: 55 °C.

Effects of the environment on the equipment

Fast temperature variations
Aim: to test the device's ability to function during changes in ambient temperature.

Reference document:
standards: IEC 60068-2-14

Severity:
Nb test, device in operation:
- device in operation
- low temperature: 0°C
- high temperature: 55°C
- speed of temperature variation: 5 ±1°C/mn
- duration of exposure at each level: 2 hours
- number of cycles: 2
- recovery: 1 hour, device energized.

Nota : *the pocket terminal is not subjected to the tests.*

Shocks / Behaviour to shocks
Aim: to test the device's ability to function in spite of shocks which may occur during normal operation.

Reference documents:
standards: IEC 60255-21-2

Severity:
Class 1:
- device in operation
- peak acceleration: 5 gn
- pulse duration: 11 ms
- number of pulses per axis: 3 in each direction.

Nota : *the pocket terminal is not subjected to the tests.*

Shock resistance
Aim: to test the device's ability to withstand shocks which may occur during transportation or handling.

Reference documents:
standards: IEC 60255-21-2

Severity:
Class 1:
- peak acceleration: 15 gn
- pulse duration: 11 ms
- number of pulses per axis: 3 in each direction.

Nota : *the pocket terminal is not subjected to the tests.*

Bumps
Aim: to check the device's ability to withstand bumps which may occur during transportation.

Reference documents:
standards: IEC 60255-21-2

Severity:
Class 1:
- peak acceleration: 10 gn
- pulse duration: 16 ms
- number of pulses per axis: 1000 in each direction.

Nota : *the pocket terminal is not subjected to the tests.*

Vibrations / Behaviour to vibrations
Aim: to test the device's ability to function in spite of vibrations during normal operation.

Reference documents:
standards: IEC 60255-21-1

Severity:
Class 1:
- device in operation
- frequency range: 10 to 150 Hz
- acceleration: 0.5 gn or 0.035 mm (peak values)
- number of cycles per axis: 1
- sweep speed: 1 octave/mn ±10%.

Nota : *the pocket terminal is not subjected to the tests.*

Vibration resistance
Aim: accelerated aging test to test the device's ability to withstand weak but long vibrations while in operation or during transportation.

Reference documents:
standards: IEC 60255-21-1

Severity:
Class 1:
- frequency range: 10 to 150 Hz
- acceleration: 1 gn (peak value)
- number of cycles per axis: 20.

Nota : *the pocket terminal is not subjected to the tests.*

Damp heat
Aim: to test the device's ability to be stored under high relative humidity conditions.

Reference documents:
standards: IEC 60068-2-3

Severity:
Ca test (continuous test).
- temperature: 40 ± 2°C
- relative humidity: 93% +2/-3%
- duration: 56 days
- crecovery: 1 hour drying at 55°C, then 1 hour cooling at 20°C before final test.

Nota : *the pocket terminal is not subjected to the tests.*

Salt mist / Test for special use only / Corrosive atmosphere
Aim: to define the atmosphere to which the device may be exposed in operation and/or storage.

Reference documents:
standards: IEC 60654-4.

Severity:
- class 1: clean industrial air.

Enclosure protection degree
Aim: to test the protection provided by the enclosure:
- for people: against direct contact with energized parts.
- or equipment: against solid foreign objects or water.

Reference documents:
standards: IEC 60529

Severity:
- front panel: IP51
- other sides:
  - without cabling accessories: IP20
  - with cabling accessories: IP21.

Nota : *the pocket terminal is not subjected to the tests.*

Fire behaviour / Glow wire test
Aim: to evaluate the risk of fire and test extinction of the flames when the product is exposed to abnormal thermal conditions.
Reference documents:
standards: IEC 60695-2-1
Severity:
- temperature: 650°C
- applied duration: 30 ±1 s.

Nota : *the pocket terminal is not subjected to the tests.*

Effects of the equipment on the environment

Aim

These tests test the level of interference (electrical, electromagnetic, etc.) generated by the device.

DC power supply

Reference documents:
standards: IEC 61131-2

Power consumption
Aim: to check the conformity of the device to specifications.
Severity: the test is performed at the rated voltages of the two operational domains, i.e. 48 V and 127 V.

Inrush current
Aim: to check the conformity of the device to specifications.

Acceptance criteria:

Time	Inrush current maximum peak
50 µs ≤ t < 1.5 ms	10 A
1.5 ms ≤ t < 500 ms	10 A
500 ms ≤ t	1.2* In (1)

(1) *In = steady-state current*

Radiofrequency interference

Conducted interference
Aim: to check the interference voltage introduced by the device at the energy network terminal posts.

Reference documents:
standards: CISPR 22

Acceptance criteria:
- maximum emission (virtually peak):
- 79 dB (µV) from 0.15 to 0.5 MHz
- 73 dB (µV) from 0.5 to 30 MHz.

Radiated interference
Aim: to test the electromagnetic field interference radiated by the device.

Reference documents:
standards: CISPR 22

Acceptance criteria:
maximum emission (virtually peak) at 10 m:
- 40 dB (µV/m) from 30 to 230 MHz
- 47 dB (µV/m) from 230 to 1000 MHz.

Reference documents

Standards

Title	Reference	Status
Vibration, shock, bump and seismic tests on measuring relays and protection equipment: vibration tests (sinusoidal).	IEC 60255-21-1	1988
Vibration, shock, bump and seismic tests on measuring relays and protection equipment: shock and bump tests.	IEC 60255-21-2	1988
Electrical disturbance for measuring relays and protection equipment: 1MHz burst disturbance tests.	IEC 60255-22-1	1988
Electrical disturbance for measuring relays and protection equipment: electrostatic discharge tests.	IEC 60255-22-2	1989-10
Electrical disturbance for measuring relays and protection equipment: radiated electromagnetic field disturbance tests.	IEC 60255-22-3	1989-10
Electrical disturbance for measuring relays and protection equipment: 1 MHz damped oscillating wave tests. sensitivity to fast transient interference tests.	IEC 60255-22-4	1992
Electromagnetic compatibility (EMC) part 4-3: testing and measurement techniques immunity to electromagnetic fields radiated at radioelectric frequencies test	IEC 61000-4-3	1998
Electromagnetic compatibility (EMC) part 4: testing and measurement techniques impulse wave	IEC 61000-4-5	1995
Single input energising quantity measuring relays with dependent specified time	IEC 60255-5	1977
Electrical relays: insulation tests	IEC 60255-6	1988
Degrees of protection provided by enclosures (IP code)	IEC 60529	1989
Programmable logic controllers: equipment characteristics	IEC 61131-2	1992
Environmental testing: general and guidance	IEC 60068-1	1988
Environmental testing: test A: cold	IEC 60068-2-1	1990-04
Basic environmental testing procedures: test N: change of temperature	IEC 60068-2-14	1986
Basic environmental testing procedures: test B: dry heat.	IEC 60068-2-2	1974
Basic environmental testing procedures: test Ca: damp heat, steady state	IEC 60068-2-3	1969
Basic environmental testing procedures: test Kb: salt mist, cyclic (sodium chloride solution)	IEC 60068-2-52	1984
Limits and methods of measurement of radio interference: characteristics of information technology equipment	IEC CISPR 22	1993
Test methods fire behaviour: glow wire test	IEC 60695-2-1	1994
Operating conditions for measurement and control equipment in industrial processes: effects of corrosion and erosion	IEC 60654-4	1987

Contents

General information **4/2**
Procedure 4/2
Equipment 4/2

Inhibition of outputs and test parameterization **4/3**
Inhibition of outputs 4/3
Test mode 4/3

Differential protection testing with simplified parameterization **4/4**

Tripping value chart **4/5**

Cabling testing by current injection **4/6**
Cabling of the injection box 4/6
Even couplings 4/6
Odd couplings 4/7

Restricted earth fault protection testing **4/8**

Test sheet **4/10**

General information

Procedure

Set the parameters
(use the setting sheets which are included in the appendix to record the values)
- status
- control logic
- protection.

Perform testing
Different test methods are proposed:
- differential protection testing with simplified parameterization.

This parameterization may be used to check the protection characteristic using two single-phase injection units. The outputs used for tripping and indication are disabled, which makes it possible to carry out this test while the network is operating normally.

- cabling testing by current injection:

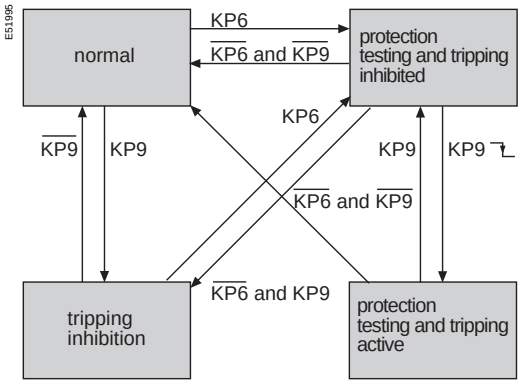
correct cabling and parameterization of the differential protection may be checked by injecting a known current in the protection and reading the phase currents, differential currents and restrained currents measured by the protection
It is recommended that this test be performed at the time of commissioning.

- restricted earth fault protection test. It is recommanded that this test be performed for each restricted earth fault used at the time of commissioning.

Equipment

- two 50 Hz (60 Hz) single-phase current generators
- 2 ammeters
- this document
- pocket terminal.

Inhibition of outputs and test parameterization



Depending on the settings of the KP6 and KP9 parameters, the protection is in one of the following 4 operating modes:
- normal
- tripping inhibited
- protection testing and tripping inhibited
- protection testing and tripping active.

Inhibition of outputs

It is useful to be able to inhibit differential and restricted earth fault protection actions, in particular to run tests while the electrical distribution system is operating normally. Parameter KP9 is used for inhibition, which consists of disabling the switching of the tripping outputs.
The indication outputs of the differential and restricted earth fault protections remain valid, allowing protection operation to be checked.

KP6 = 0	KP9 = 0	normal mode	outputs: all operative Indicator off message: ----------
	KP9 = 1	tripping inhibited	outputs inoperative according to chart "test" indicator on message: INHIBIT.

	output inoperatives	**indication outputs operative**
Sepam D22	O1, O2, O12, O13	O14 (differential or restricted earth fault)
Sepam D32	O1, O2, O12, O13, O21, O22	O14 (differential or restricted earth fault)

Chart of output sattus in tripping inhibited mode

Test mode

The test mode is designed to simply current injection for the differential protection test.
The test mode is obtained by using the KP6 parameter.
The changeover to test mode automatically parameterizes the differential protection.
- vector groups equal to 0
- Un, Un' and Un" values such that Un.In = Un'.In' = Un".In".

It disables switching of the tripping outputs. Upon the return to normal mode (KP9 = 0), the initial parameter settings are recovered and the outputs become active again.

Changeover from normal mode to test mode		
KP6 0 → 1 (whatever the value of KP9)	protection test mode and tripping inhibited	outputs inoperative according to chart "Test" indicator blinking message: TEST COUPL.
Test mode:		
KP9 0 → 1 → 0 or KP9 1 → 0 (KP6 = 1)	protection test mode and tripping active	Outputs: all operative "Test" indicator blinking message: TEST COUPL.
Return to normal normal		
KP6 1 → 0 (KP9 = 0)	no inhibition	Outputs: all operative Indicator off message: ---------- reset
KP6 1 → 0 (KP9 = 1)	inhibition	outputs inoperative according to chart "Test" indicator blinking message: INHIBIT reset

Differential protection testing with simplified parameterization

■ Parameterization of the protection in **Test** mode (setting pocket terminal) KP6 = 1.
The test indicator is on.

Caution
This operation should be carried out first since it inhibits protection tripping.

■ Wiring in accordance with the diagram opposite.
□ for Sepam 2000 D22 connect the injection boxes to the ECMD2 and ECMD3 boards.
□ for Sepam 2000 D32, carry out two tests, one with the injection boxes connected to the ECMD2 and ECMD3 boards and the other with them connected to the ECMD2 and ECMD4 boards.

■ Return to normal operation: carry out the operations in the following order:
1. disconnect the injection units
2. normal operating mode (KP6 = 0).
The test indicator is off.

***Nota :** the return to normal operating mode by KP6 = 0 clears all messages and latching.*

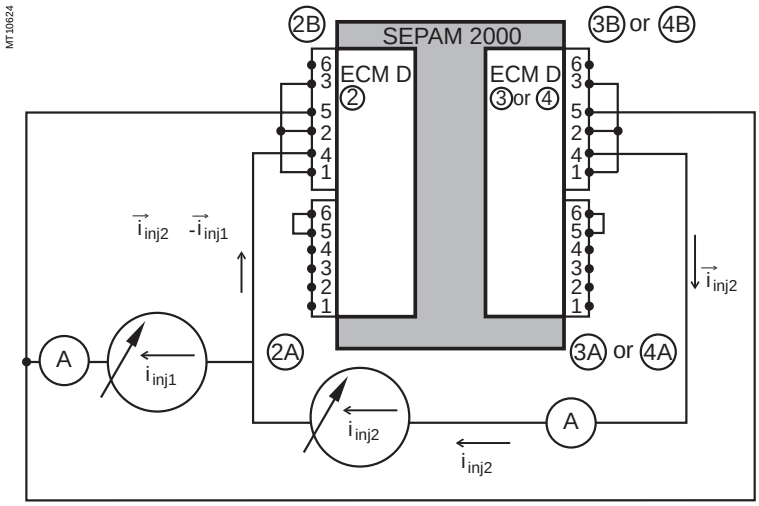


Diagram
This advantage of this arrangement is that the differential current i_{inj1} and through current i_{inj2} are injected directly.
For that purpose i_{inj1} and i_{inj2} must be in phase and injected as shown in the figure above with $i_{inj2} > i_{inj1}$.

■ Notation :
In: CT rated current for winding 1
I'n: CT rated current for winding 2
in: 1A or 5A
I1, I2, I3: phase current for winding 1
I'1, I'2, I'3: phase current for winding 2
i_{inj1}, i_{inj2}: injected currents
Id1, Id2, Id3: phase differential currents 1, 2, 3
It1, It2, It3: phase through currents 1, 2, 3.

■ Calculated currents by Sepam (and accessible via the TSM2001):

$I1 = (i_{inj2} - i_{inj1}) \times (In / in)$	$Id1 = i_{inj1} \times (In / in)$	
I2 = I1	Id2 = Id1	
I3 = 0	Id3 = 0	
$I'1 = i_{inj2} \times (I'n / in)$	$It1 = i_{inj2} \times (In / in)$	(nota: $i_{inj2} > i_{inj1}$)
I'2 = I'1	It2 = It1	
I'3 = 0	It3 = 0	

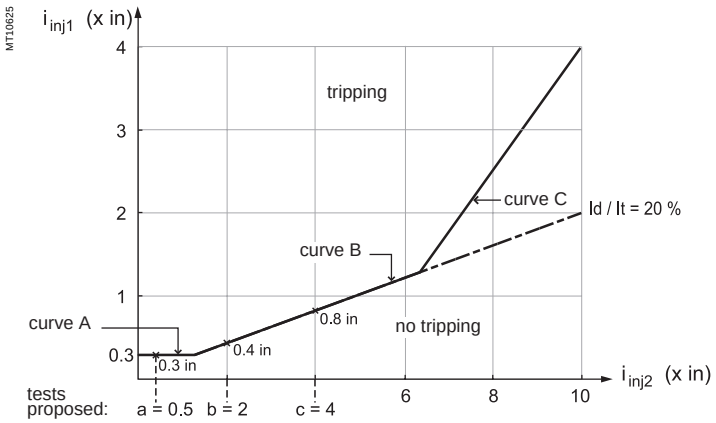
Example of tripping curve at Id / It = 20%

The different curves:

curve A: $i_{inj1} = 0.3$ in

curve B: $i_{inj1} = (Id / It) \times i_{inj2}$
with Id/It the setting of the protection

curve C: $i_{inj1} = 0.744_{inj2} - 3.475$ in
(approximation between 6 in and 10 in at ± 5%).



Tripping value chart

The following chart gives an indication, according to the through current injected and the Id/It setting, of the differential currrent (xin) value as of which the protection trips.

Id (xin)	**Id/It (setting of the protection)**							
It (xin)	**0.15**	**0.2**	**0.25**	**0.3**	**0.35**	**0.4**	**0.45**	**0.5**
0.0	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
0.5	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
1.0	0.300	0.300	0.300	0.300	0.350	0.400	0.450	0.500
1.5	0.300	0.300	0.375	0.450	0.525	0.600	0.675	0.750
2.0	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000
2.5	0.375	0.500	0.625	0.750	0.875	1.000	1.125	1.250
3.0	0.450	0.600	0.750	0.900	1.050	1.200	1.350	1.500
3.5	0.525	0.700	0.875	1.050	1.225	1.400	1.575	1.750
4.0	0.600	0.800	1.000	1.200	1.400	1.600	1.800	2.000
4.5	0.675	0.900	1.125	1.350	1.575	1.800	2.025	2.250
5.0	0.750	1.000	1.250	1.500	1.750	2.000	2.250	2.500
5.5	0.825	1.100	1.375	1.650	1.925	2.200	2.475	2.750
6.0	1.032	1.200	1.500	1.800	2.100	2.400	2.700	3.000
6.5	1.344	1.344	1.625	1.950	2.275	2.600	2.925	3.250
7.0	1.656	1.656	1.750	2.100	2.450	2.800	3.150	3.500
7.5	2.016	2.016	2.016	2.250	2.625	3.000	3.375	3.750
8.0	2.376	2.376	2.376	2.400	2.800	3.200	3.600	4.000
8.5	2.736	2.736	2.736	2.736	2.975	3.400	3.825	4.250
9.0	3.144	3.144	3.144	3.144	3.150	3.600	4.050	4.500
9.5	3.552	3.552	3.552	3.552	3.552	3.800	4.275	4.750
10.0	4.008	4.008	4.008	4.008	4.008	4.008	4.500	5.000
10.5	4.488	4.488	4.488	4.488	4.488	4.488	4.725	5.250
11.0	4.992	4.992	4.992	4.992	4.992	4.992	4.992	5.500
11.5	5.544	5.544	5.544	5.544	5.544	5.544	5.544	5.750
12.0	6.120	6.120	6.120	6.120	6.120	6.120	6.120	6.120
12.5	6.720	6.720	6.720	6.720	6.720	6.720	6.720	6.720
13.0	7.320	7.320	7.320	7.320	7.320	7.320	7.320	7.320
13.5	7.920	7.920	7.920	7.920	7.920	7.920	7.920	7.920
14.0	8.496	8.496	8.496	8.496	8.496	8.496	8.496	8.496
14.5	9.048	9.048	9.048	9.048	9.048	9.048	9.048	9.048
15.0	9.576	9.576	9.576	9.576	9.576	9.576	9.576	9.576
15.5	10.032	10.032	10.032	10.032	10.032	10.032	10.032	10.032
16.0	10.488	10.488	10.488	10.488	10.488	10.488	10.488	10.488
16.5	10.896	10.896	10.896	10.896	10.896	10.896	10.896	10.896
17.0	11.280	11.280	11.280	11.280	11.280	11.280	11.280	11.280
17.5	11.640	11.640	11.640	11.640	11.640	11.640	11.640	11.640
18.0	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000
18.5	12.336	12.336	12.336	12.336	12.336	12.336	12.336	12.336
19.0	12.648	12.648	12.648	12.648	12.648	12.648	12.648	12.648
19.5	12.960	12.960	12.960	12.960	12.960	12.960	12.960	12.960
20.0	13.248	13.248	13.248	13.248	13.248	13.248	13.248	13.248
20.5	13.560	13.560	13.560	13.560	13.560	13.560	13.560	13.560
21.0	13.848	13.848	13.848	13.848	13.848	13.848	13.848	13.848
21.5	14.136	14.136	14.136	14.136	14.136	14.136	14.136	14.136
22.0	14.424	14.424	14.424	14.424	14.424	14.424	14.424	14.424
22.5	14.712	14.712	14.712	14.712	14.712	14.712	14.712	14.712
23.0	14.976	14.976	14.976	14.976	14.976	14.976	14.976	14.976
23.5	15.264	15.264	15.264	15.264	15.264	15.264	15.264	15.264
24.0	15.552	15.552	15.552	15.552	15.552	15.552	15.552	15.552

Cabling testing by current injection

Cabling of the injection box

■ Inhibition of tripping outputs by KP9 = 1; the test indicator is on.

■ Cabling of the injection box
□ Sepam D22: connect the injection box to the ECMD2 and ECMD3 boards using the diagram that matches the time index set (index').
□ Sepam D32: carry out 2 tests
Connect the injection box to the ECMD2 and ECMD3 boards using the diagram that matches the time index (index') set; carry out the first test.
Connect the injection box to the ECMD2 and ECMD4 boards using the diagram that matches the time index (index") set: carry out the second test.

■ Calculation of the injection coefficient k

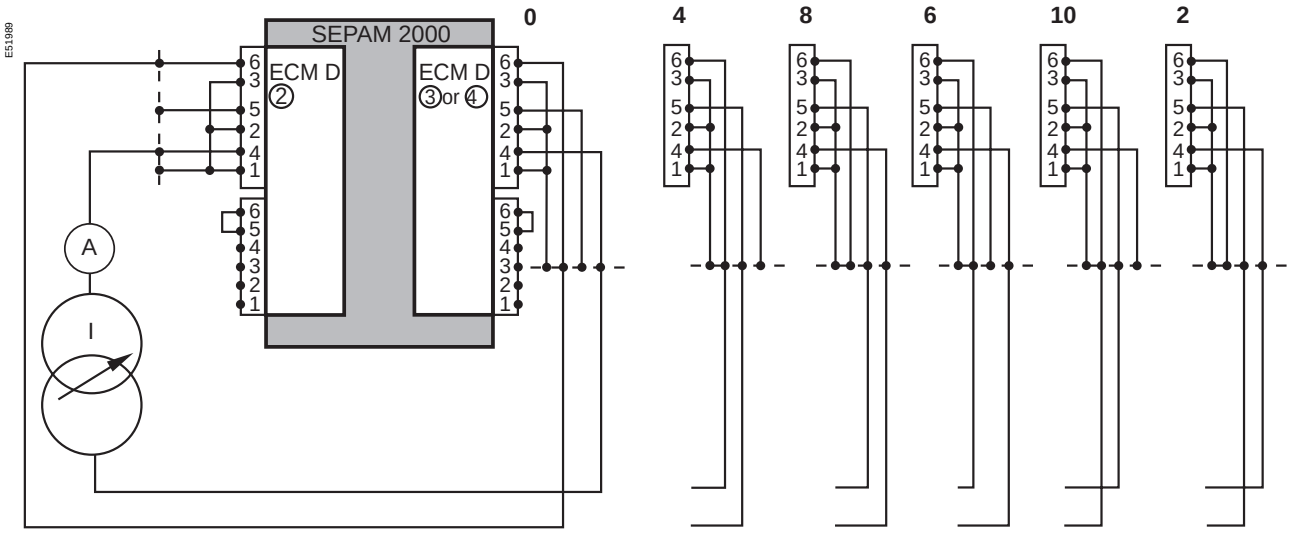
$$k = \frac{Un' \; In'}{Un \; In}$$ (test between windings 1 and 2)

$$k = \frac{Un'' \; In''}{Un \; In}$$ (test between windings 1 and 3) (1)

In, In', In"(1) CT rated current, windings 1, 2 and 3 (1)
Un, Un', Un"(1) rated voltage, windings 1, 2 and 3 (1)
(1) *Sepam 2000 D32 only*

■ Reading of measurements taken by Sepam 2000 (using the pocket terminal, **Add.reading** menu) and comparison with the theoretical values.
Use the test sheet which is found at the end of this manual.

Even couplings



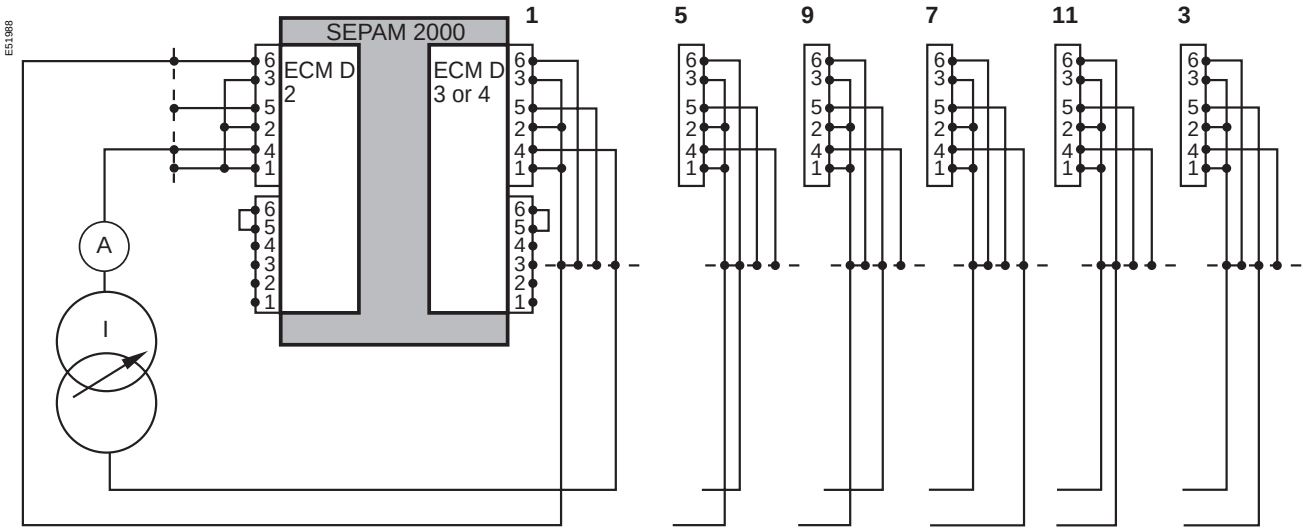
Measurement values available on the pocket terminal according to the currents injected

Add.reading - Idiff. and Itrav.							
Id1 = abs(1-k).I.In/in	**It1** = max (1,k).I.In/in						
Id2 = 0	**It2** = 0						
Id3 = abs(1-k).I.In/in	**It3** = max (1,k).I.In/in						
Add. reading - I or I' phase							
I1 = I.In/in	**I1'**	= I.In'/in	= 0	= I.In'/in	= I.In'/in	= 0	= I.In'/in
I2 = 0	**I2'**	= 0	= I.In'/in	= I.In'/in	= 0	= I.In'/in	= I.In'/in
I3 = I.In/in	**I3'**	= I.In'/in	= I.In'/in	= 0	= I.In'/in	= I.In'/in	= 0
		0	**4**	**8**	**6**	**10**	**2**

in: CT secondary rated current; in = 1 A or 5 A.

Cabling testing by current injection

Odd couplings



Measurement values available on the pocket terminal according to the currents injected:

Special function - Idiff. and Itrav.							
Id1 = $\left\lvert 1 - \frac{k}{\sqrt{3}} \right\rvert$. I .In/in	**It1** = max $\left[1, \frac{k}{\sqrt{3}} \right]$. I .In/in						
Id2 = 0	**It2** = 0						
Id3 = $\left\lvert 1 - \frac{k}{\sqrt{3}} \right\rvert$. I .In/in	**It3** = max $\left[1, \frac{k}{\sqrt{3}} \right]$. I .In/in						
Special function - I and I' phase							
I1 = I.In/in	**I1'**	= I.In'/in	= 0	= 0	= I.In'/in	= 0	= 0
I2 = 0	**I2'**	= 0	= 0	= I.In'/in	= 0	= 0	= I.In'/in
I3 = I.In/in	**I3'**	= 0	= I.In'/in	= 0	= 0	= I.In'/in	= 0
		1	**5**	**9**	**7**	**11**	**3**

in: CT secondary rated current; in = 1 A or 5 A.

Restricted earth fault protection testing

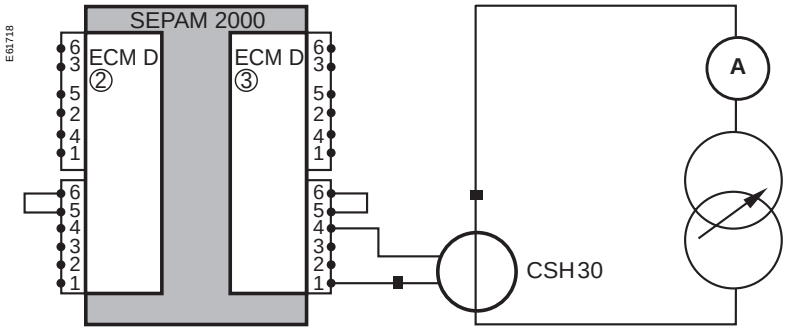
■ Parameterization of the protection for Test coupling (using the pocket terminal, KP6 = 1).
The test indicator lights up.

Please note
This operation should be carried out first since it inhibits tripping of the protection.

■ Checking of the setting:
The Iso set point is checked by simulating a fault between the neutral point CT and a phase CT, when the circuit breaker is open. In this case, only the neutral point CT detects the fault. There is zero restraint current.

To perform the test, wire according to the diagram opposite.

Inject a current in the CSH 30 sensor associated with the neutral point current measurement CT to check the value of the setting.

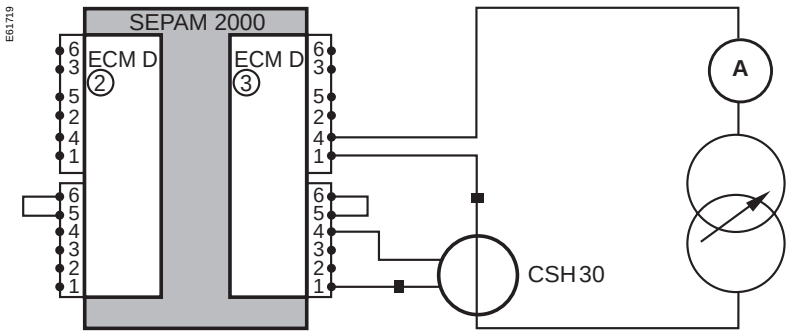


5 A neutral point current CT: 1 turn
1 A neutral point current CT: 5 turns

■ Check the stability:
The stability is checked by considering a phase-to-earth fault outside the zone to be protected.
This test is only possible if Ino = In for the winding to which the restricted earth fault protection is connected.

To perform the test, wire according to the diagram opposite.

Inject a current into the CSH 30 sensor associated with the neutral point current CT and into one of the phase current inputs to simulate a fault outside the zone.
Check the stability for a current of 2 In.

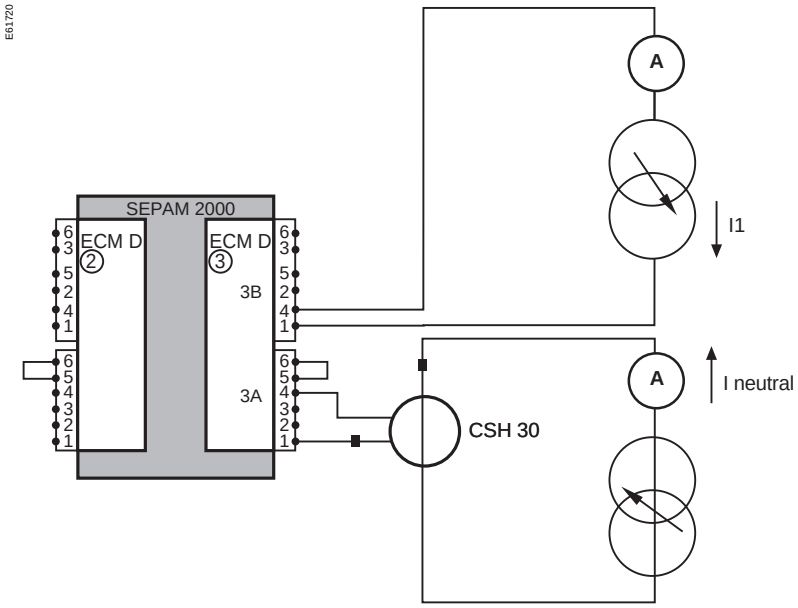


5 A neutral point current CT: 1 turn
1 A neutral point current CT: 5 turns

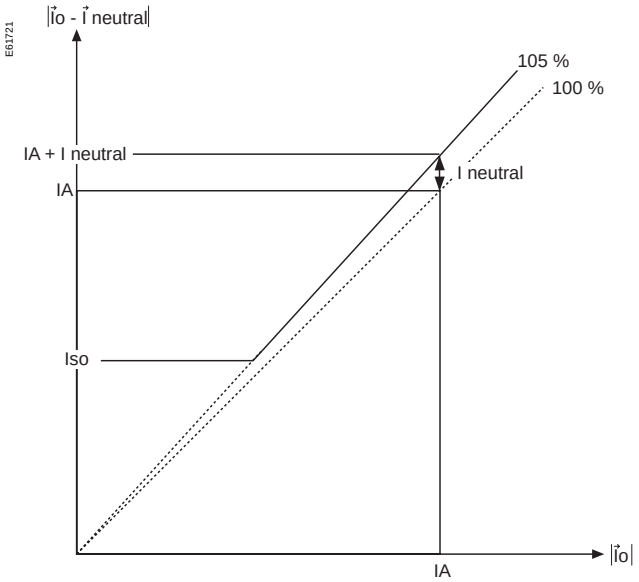
Restricted earth fault protection testing

■ Checking of the slope

The slope can be checked by simulating a phase-to-earth fault inside the zone to be protected on a network with the circuit breaker closed. In this case, the fault is detected by the neutral point CT and partially by the phase CT.
To facilitate the test and calculations, set Ino to the same value as In.
To perform the test, wire according to the diagram opposite.



To facilitate the test and calculations, set Ino to the same value as In.
Inject a current through the CSH30 interposing ring CT and a phase current in the opposite direction.
The restraint current is equal to I1, the differential current is equal to I1 + I neutral.
When there is no I neutral, the slope is equal to 100%. Gradually inject Io until tripping occurs. Record I neutral and I1 and calculate 100 x (I1 + I neutral)/I1 and compare to 105%.



■ To return to normal operation, perform the operations in the following order:
1. disconnect the injection box;
2. restore normal operation mode;
the test lamp is off; the messages and latching are reset to zero.

Test sheet

Project: ..... Switchboard: ..... Panel:	Transformer differential protection Type of Sepam 2000 D Serial number

Cabling testing by current injection

index' = ...
index" = ...
In = ...
I'n = ...
I"n = ...

injection coefficient: (1)
k = ...= .....
Un = ...
Un' = ...
Un" = ...

test between windings 1 and 2 ☐
test between windings 1 and 3 ☐
Current injected: I = ...

Variable	Formula (1)	Value calculated	Tolerance	Value read	
I1	.....	.....	±5 %	.....	☐
I2	.....	.....	±5 %	.....	☐
I3	.....	.....	±5 %	.....	☐
I1'	.....	.....	±5 %	.....	☐
I2'	.....	.....	±5 %	.....	☐
I3'	.....	.....	±5 %	.....	☐
I1''	.....	.....	±5 %	.....	☐
I2''	.....	.....	±5 %	.....	☐
I3''	.....	.....	±5 %	.....	☐
Id1	.....	.....	±10 %	.....	☐
Id2	.....	.....	±10 %	.....	☐
Id3	.....	.....	±10 %	.....	☐
It1	.....	.....	±10 %	.....	☐
It2	.....	.....	±10 %	.....	☐
It3	.....	.....	±10 %	.....	☐

***(1)** Copy the formulas which appear in the manuel*

Differential protection testing with simplified parameterization

Id / It = ... %

Procedure:
- sed i_{inj2} to the value indicated in the chart
- gradualy increase i_{inj1} until the protection trips
- read the value of i_{inj1}
- compare it to the theoretical value.

Test n°	i_{inj2}	Tripping current i_{inj1}	i_{inj1} / i_{inj2}	Tripping theorical value	
a	0.5 in	..... A		i_{inj1} = 0.3 in	☐
b	2 in	..... A	.....	i_{inj1} / i_{inj2} = Id / It	☐
c	4 in	..... A	.....	i_{inj1} / i_{inj2} = Id / It	☐

in = 1 ou 5 A
Id/It : seuil à pourcentage, exprimé en %

Tests carried out on: ☐☐/☐☐/☐☐ **by:**	**Signature**	**Signature**

Comments: .....
.....
.....
.....
.....

Schneider Electric Industries SA
Postal adress:
F - 38050 Grenoble cedex 9
France

Tél : +33 (0)4 76 57 60 60

http://www.schneider-electric.com

As standards, specifications and designs change from time to time, please ask for confirmation given in this publication.

This document has been printed on ecological paper

Publishing: HeadLines
Desing: Schneider Electric
Printing: Imprimerie des 2 ponts

ART.05505

01-2002

PCRED301042EN - 5124527EN/A0 © 2002 Schneider Electric - All right reserved